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NEW SERIES, VOLUME L

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# The American Journal of Surgery

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A PRACTICAL JOURNAL BUILT ON MERIT

## EDITORIAL

### THREE BOOKS\*

BESIDE us as we write are three books that deserve more attention than is possible in the usual professional review. In fact, this is no attempt to do other than tell you how unusual and good these books are. One of them is the autobiography of a master surgeon, an acknowledged pioneer in his specialty; another is a volume dated June 1, 1940, a birthday tribute to a master craftsman and surgical pioneer; the last is an autobiography, slightly camouflaged by its writing technic, of a gentleman of parts who also pioneered and reached the heights, and who died just the other day.

Hugh Young—A Surgeon's Autobiography, is the life and work of Hugh Young of Baltimore. In his preface, fearing no doubt that he might be accused of conceit, he tells us how he came to write and have this volume published. When we consider what the author has accomplished in his lifetime, his modesty is refreshing. We read accounts of his vigorous and individual forebears who helped shape his future life. It is lively reading, but all too soon he begins what is really a history of urology in this country and the part he played in it. Inasmuch as he was one of the crusaders and grew up with this branch of medicine,

he is just the man to leave this history to posterity. In the frontispiece is a reproduction of a painting of Dr. Young by Sir William Orpen, and William P. Didusch has contributed over a hundred drawings. It is a delightfully written book and one that is sure to fascinate physicians and surgeons and especially urologists.

It is now the fashion to honor one in the flesh and not wait for postmortem memorials. This is fitting and as it should be. The background of one who has earned a position in high places and who has won the esteem of his fellow workers is often a story of hard work and backbreaking, drab labor. Therefore, it is little enough on a special occasion for his friends to gather round him and give a cheer. This happened to Frank Howard Lahey of Boston on the occasion of his sixtieth birthday. His medical and lay friends on this occasion tendered him a Birthday Volume which was an apt tribute and a gracious gesture. Over fifty physicians and scientists whose names are bywords in the world of science and medicine have contributed forty-nine technical or scientific articles. Walter C. Alvarez contributed, "Congratulations to Dr. Frank Lahey," and the book ends with "An Appraisal" by Arthur W. Booth.

\* Hugh Young—A Surgeon's Autobiography. Harcourt, Brace and Company, 1940.

Frank Howard Lahey—Birthday Volume. Charles C. Thomas, 1940.

As I Remember Him—The Biography of R. S. By Hans Zinsser. Little, Brown and Company, 1940.

Once in your hands you will read it from cover to cover. Typographically it is a beautiful book and something lovely to look at; it is a work that is certain to stand out in the medical literature for a long time to come; and it was a fitting offering to a surgeon who in the early autumn of his career has meant so much to surgery as a master craftsman, inventor, teacher and author.

About a week ago (September 4, 1940) we bought Hans Zinsser's book (it was not sent to us for review) and that day began to read it; on that same day we read of the author's death. We have now put "As I Remember Him—The Biography of R. S." on our night table so that we can pick it up before sleep and reread many parts. We enjoyed Zinsser's "Rats, Lice and History," but this informal and unusual biography of R. S.—who is none other than the author—is truly a classic. In this estimate of his work the majority of the professional reviewers have agreed without a dissenting opinion. As most of us know, Zinsser was a man of many accomplishments; he was a poet, a lover of the classics, he acquired a broad culture, was a philosopher of no mean degree and a linguist, and as a bacteriologist was known the world over. His work on typhus, alone, earned for him a permanent place in medical history. His sense of humor and of the ridiculous was broad and keen. He was interested in so many things; he dipped his

fingers into so many places; he knew and lived with all kinds of people; he never sidestepped an argument. He was a positive fellow, although in his writing he tells us that often he was in the wrong. A profound student, a true friend, he knew his days were numbered, that the end would overtake him swiftly (he had leukemia), and the part of his book in which he tells us of his philosophy in the ebbing time of his life is a moving recital. He does not resort to cheap tricks of writing. He does not pity himself nor seek the sympathy of the reader. These pages are stirring and beautiful and will be read and reread many times. It is not often that such a book appears; in the language of the man of the streets, "it has everything." In many portions of the book the reader will pause and see himself when a young man early in his medical career; at other parts he will stop reading, close his eyes and slowly digest what he has read—and then dream. You'll find this book, by one of us who died too soon, a work you'll want to own, and after you have read the last line you will wish it was many times longer.

These three books, two written by figures that loom large on the medical canvas, and one a birthday volume, a tribute to a man who has been a surgical pioneer and a leader in the ranks of organized medicine, might well grace the shelves of historical medicine for now and the years to come.

T. S. W.



# ORIGINAL ARTICLES

## RUPTURE OF THE QUADRICEPS TENDON\*

WITH A REPORT OF THREE CASES

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### INTRODUCTION

THE function of leg extension is accomplished by a muscle and tendon ensemble composed of the rectus femoris and the three vasti muscles, the tendons of which converge in their inferior portion to be united into one common tendon, the *quadriceps tendon*. This tendon, partially interrupted in its course by a large sesamoid bone, the patella, is inserted in the anterior tuberosity of the tibia. It has seemed timely to review the types of quadriceps tendon injury and herewith are reported three varieties of this injury.

### HISTORICAL

The first recorded mention of quadriceps tendon injury is in the writings of Galen, who stated that "during a wrestling match, the patellar ligament was broken, and after healing, the patient, who was a young man, could not flex the knee nor walk on an inclined plane without risk of falling."

Following Ruysch's paper in 1720, J. Louis Petit reported three cases in 1723. Schlichting (1742), Molinelli (1767), Sedillot (1786), Saucerotte (1801), Dupuytren (1816 and 1817), and Vanderlinden (1834), all reported individual observations on this theme. In England, Samuel (1838) is the first to record a case of rupture of the quadriceps tendon in the English literature. Continued mention of the condition was made by the French observers Demarquay (1842), Boyer (1845), and Binet (1858).

A capital fact which dominated the history of this condition as well as the treatment, was the advent of asepsis, for up to 1878 when Lister practiced suture of the tendon under antisepsis for the first time, the treatment had been purely medical, by means of packs, poultices and immobilization of the extremity. Maydl's article (1883) is an elaborate study of this injury in connection with fractures of the patella and rupture of its ligament, all the cases being treated without operation. E. Blanc (1887) in reporting a ruptured quadriceps tendon case, again advocated the nonoperative treatment.

It is of more than passing interest to note that the first successful operative result in the United States was reported by Charles McBurney of New York in 1887. He had operated on a 50 year old male in 1885 for a ruptured quadriceps tendon which he sutured with catgut and silver wire. Bull (1889), after reviewing the literature up to this time, reports an operative case of his own with successful outcome and in addition, records the first four reported operated cases of suture of the quadriceps tendon. These were McBurney's (1885), Lünig's (1880), Wilkin's (1887), Hartley's (1888).

To Poirier (1899) we are indebted for a most meticulous anatomopathologic description of the muscle planes comprising the quadriceps extensor apparatus as well as for a more complete understanding of the variations in the different clinical types.

\* From the Second Surgical Division, St. Vincent's Hospital, New York City, Dr. R. P. Sullivan, Director.



Quenu and Duval (1905) review a series of twenty-one operative cases and detail the necessity and methods of surgical treatment. Their results were creditable.

Ombredanne, in 1906, made a series of anatomic studies on the cadaver to outline the causation of this injury. McMaster (1933) experimented on rabbits, producing tendon and muscle ruptures. Of the more recent reports of cases, the following: Ottolenghi and Pique (1935), Austoni (1936), Lenormant and Olivier (1933), Clapp (1921), Gabilland (1929-1930), Guillaume-Louis (1928), Delbet (1924), Jeanne-ney (1929), Quilichini (1932), Guilemen (1928), Vanlande (1928), Michel (1928), Sejournet (1927), Bolognesi (1931), Brun (1933) and Gilcreest (1933) have all contributed appreciably to our present day concept of the problem.

#### ETIOLOGY

**Occurrence.** Despite some reports, it is our experience that rupture of the quadriceps tendon is a rather infrequent catastrophe. For the past five years, there have been only five cases treated at St. Vincent's Hospital. This is a rather striking fact in view of the situation of the institution in a busy metropolis and its proximity to industry. Only three cases required surgical intervention as the other two were incomplete muscular tears.

As compared to the total causes of disruption of the extensor apparatus of the leg, ruptures of the quadriceps tendon form but a small percentage. Clap<sup>16</sup> reports this incidence in a series of seventy cases from the service of Professor Delbet. (Table I.)

TABLE I

	Cases	Percentage
1. Fractures of the patella	62	88 5
2. Rupture of patellar ligament	4	5 7
3. Rupture of quadriceps tendon	3	4 2
4. Rupture of tendon with the tearing away of the tibial tuberosity	1	1 4

The majority of all cases have been in men between the ages of 30 and 50 years of age and many observers believe that the ruptures occur in muscles and tendons predisposed to their production. The occurrence in the young is exceptionally infrequent, and although Potherot reports a case in a child of 5 years, the condition is rare before 20.

**Causes.** Many authors have postulated predisposing and local causes for the occurrence of this injury. (Table II.)

TABLE II

Predisposing causes	1	Metabolic disorders { gout diabetes arteriosclerosis obesity
	2	Lux
	3	Chronic nephritis
	4	Old poliomyelitis
	5	Chronic osteoarthritis
	6	Acute infectious diseases as typhoid, etc
	7	Trichinosis
	8	Unusually heavy labor
	9	Congenital defects { fragilitas ossium osteopsathyrosis
Local causes	1	Ankylosis of knee joint
	2	Hydroarthrosis
	3	Periarticular lesions of chronic arthritis
	4	Muscle degenerations
	5	Calcareous infiltration of tendinous insertions
	6	Trauma { direct indirect

Lenormant and Olivier believe that a great number of cases of rupture are prepared for by modifications in the structure of the patella itself.

**Determining or Immediate [Inducing Causes.** Sometimes the actual inducing cause is apparently slight—a physiologic act such as walking, ascending or descending a flight of stairs, movements made on turning around. Certain observers even speak of "spontaneous ruptures." McMaster's studies on animals and the clinical observations derived therefrom are of intense interest in this respect:

1. Normal tendon did not rupture when subjected to severe strain. Either the tendon insertion pulled away; the muscle belly ruptured; the musculotendinous junction separated; the muscle origin pulled out; or fracture of the bones occurred. The tendon or muscle, in pulling away from either insertion or origin, detached a small fragment of bone.

2. Approximately one-half of a tendon's fibers had to be severed to permit of immediate rupture when subjected to severe strain. Spontaneous rupture did not occur following severance of approximately three-fourths of a tendon's fibers under ordinary activity.

3. Obstruction to the blood supply of 1 cm. of a normal tendon by double ligation caused rupture in this obstructed area as early as four weeks afterwards, when it was subjected to strain, even though the tendon sheath had been carefully replaced.

4. The blood supply of a tendon was more important in the separative processes of injured tendons than the presence of the tendon sheath.

McMaster's clinical conclusions, based on his experimental animal studies, were that when a normal muscle-tendon system is subjected to severe strain, the tendon does not rupture. However, rupture may occur (1) at the insertion of the tendon to bone; (2) at the musculotendinous junction; (3) through the belly of the muscle; and (4) at the origin of the muscle from the bone. Either the muscle or the tendon may pull away a small fragment of bone, and sometimes the strain results in fracture or dislocation. Disease processes in tendons predispose to their "*spontaneous rupture*" often from only slight strain as in tendons affected by (1) tuberculous tenosynovitis, (2) gonococcal tenovaginitis, and (3) trichiniasis, typhoid, lues, or tumors. Rupture of muscle fibers occurs following both direct and indirect types of trauma. Degenerative changes and disease processes in muscles predispose to their rupture. Minimal to more extensive muscle ruptures occur following varying degrees of direct or indirect trauma and are often overlooked in clinical cases.

Quilichini indicates that "almost all the traumatic ruptures of the quadriceps due to *indirect* violence occur as a result of pure muscular contraction following such forced muscular movements as are employed in the effort to avoid an impending, oncoming or imminent fall." These are produced

almost exclusively in men who are vigorous and who are engaged in either muscular tasks or very active work. The ruptures due to *indirect* violence are less frequent, but nevertheless have an equally important etiology. Spontaneous ruptures are extremely rare. The factors producing them are the same as those which produce similar ruptures in other muscles. General diatheses as the causes were found by Hofeman in two cases due to tabes; by Chavannez in one case due to tuberculosis and rheumatism; by Ritter in one case due to old lues; by Frankenthall in a case due to diabetes; by Maydl and Vulpius in cases due to local degenerative affections; and by Kalliebe in a case due to fatty infiltration of muscle.

Ordinarily, the muscular contraction is very violent and usually a misstep or an attempt to regain one's balance is made following an effort to avoid a fall. This produces a rupture of the extensor apparatus and the fall then occurs actually as a result of the rupture. Of Bull's five operative cases reported in 1889, three were the result of direct blows or lacerating assaults, and two were the result of indirect violence. Binet reports that in twenty-four cases the rupture of the quadriceps tendon occurred fourteen times after an effort to avoid a fall. Sellier, in reporting twenty-seven cases of patellar ligament rupture where the cause of rupture was indicated, states that fifteen were due to a misstep in an attempt to avoid a fall; eleven were due to a fall with the leg flexed on the thigh; and one was due to spontaneous rupture in the course of walking or marching. Ombrédanne (1906), in his experiences with the cadaver, demonstrated in his effort to produce rupture of the quadriceps tendon by direct violence that when the leg was in extension and the patella naturally in a state of relaxation, rupture of the tendon in either its suprapatellar or infrapatellar portions was impossible. In addition, he concluded that muscular contraction was at the basis of all ruptures by indirect violence. Usually by making an effort to resist an obstacle

the patient breaks his tendon by indirect violence.

Sellier, in twenty-one cases, found the tendon ruptured at the superior patellar insertion in six cases; at the superior

of the *vastus intermedius* or *crureus* muscle and containing little of the tendinous parts. (Figs. 1 and 2.) If the superficial plane tears at the level of the patellar insertion, then the *middle plane* tears at a higher level.

TABLE III  
CLINICAL VARIETIES OF RUPTURE

i. Suprapatellar ruptures	A. Pure muscular	fibrillar tears	
		partial rupture	
	B. Musculotendinous	laceration	
		with joint involvement	
	C. Tendinous tears	without joint involvement	
		at junction of muscle	with joint involvement
ii. Infrapatellar ruptures	A. At the inferior border of patella	without joint involvement	
		at midpoint of tendon	without bone detachment
	B. At midportion of patellar ligament	at patellar attachment	with bone detachment
		C. At insertion of quadriceps tendon	without bone injury
	without tibial bone damage		
	with tearing away of anterior tibial tuberosity		

patellar insertion with bone lesion in one case; at the midportion of the patellar tendon in three cases; at the inferior patellar margin in nine cases; and at the tibial insertion in two cases.

#### PATHOLOGIC ANATOMY

The anatomic structure of the extensor apparatus explains the varieties of ruptures encountered. Four muscles form the quadriceps femoris—these are the rectus femoris and the three vasti muscles, *lateralis*, *medialis*, and *intermedius* or *crureus*. These muscles are distinctive in that they unite in the formation of one common tendon and that they have the largest sesamoid bone in the body incorporated in this tendon.

To Poirier we are indebted for the first concise description of the surgical anatomy of the quadriceps extensor apparatus. The inferior insertion of the quadriceps femoris is very complex and the several parts which comprise it do not rupture, as a rule, at the same time. As was pointed out, the tendinous insertion is composed of three planes. The planes are: (1) a *superficial* or *anterior* plane containing the *rectus femoris*; (2) a *second* or *middle* plane comprising the *vastus lateralis* and *vastus medialis*; and (3) the *third* or *posterior* plane consisting

When the *third* or *posterior* plane tears, it is generally at a still higher level than the other two planes and in an irregular manner.

When the *vastus intermedius* or *crureus* muscle is lacerated, the quadriceps *cul-de-sac* or pouch is torn and the synovium is involved in the rupture. The hemarthrosis present in this type of rupture is due invariably to this tear of the synovium at the base of the quadriceps bursa. From this it may be seen that ruptures of the quadriceps extensor apparatus may be partial or complete. If complete they are tears throughout the entire three planes. Partial ruptures are usually in the rectus femoris only.

The principal tendinous portion of the apparatus is the quadriceps tendon which is fixed into the anterior tibial tuberosity. It is interrupted in its course by the large sesamoid. This bone divides the tendon into the suprapatellar portion and the infrapatellar portion, also known as the patellar or tibiopatellar ligament.

Now the *superficial* or *anterior plane* consists of the rectus femoris and the most anterior fibers are only slightly adherent to the patella. They proceed without interruption to the insertion at the tibial

tubercle. But the greater part of the fibers are fixed into the base of the patella in its *anterior edge* and to the *anterior face* along the *superior edge*.

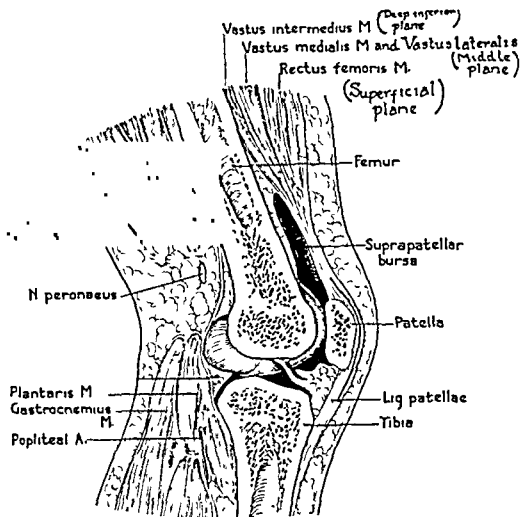


FIG. 1. Sagittal section to show the three planes comprising the quadriceps extensor apparatus. (1) The *superficial* or *anterior plane* formed by the rectus femoris muscle. (2) The *middle plane* formed by the decussating fibers of the vastus medialis and vastus lateralis muscles. (3) The *deep* or *posterior plane* made up by the vastus intermedius or crureus muscle.

The tendons of the vastus medialis and vastus lateralis united with each other on the inferior segment constitute the *middle plane* immediately behind the insertion of the rectus femoris, in such a way that their lowermost fibers come to end along the lateral edges of the patella.

Finally, the tendon of the vastus intermedius or crureus is fixed into the patella below the insertions of the vastus medialis and vastus lateralis and constitutes the *deep plane* of the quadriceps tendon. These various planes differ from each other in the direction of their fibers. The fibers of the tendon of the *rectus femoris* and the *crureus* (vastus intermedius) run parallel to the long axis of the quadriceps whereas the fibers of the vastus lateralis and vastus medialis converge towards each other and form a tendinous V at the point where they become affixed to the patella.

The infrapatellar portion of the quadriceps tendon, called the patellar ligament, extends from the apex of the patella to the

anterior tibial tuberosity. The superficial aspect of this portion is covered by the arciform fibers. A certain number of the quadriceps fibers do not attach directly or

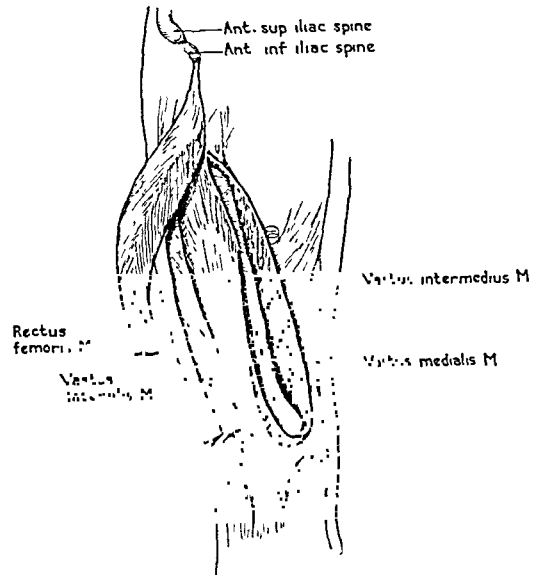


FIG. 2. Anatomic figure to demonstrate the three planes which comprise the quadriceps tendon in its suprapatellar position. The deep plane of the vastus intermedius is shown as well as the middle plane of the decussating fibers of the lateral and medial vastus muscles. The superficial plane of the rectus femoris has been turned out in order to show the deeper structures.

indirectly to the anterior tibial eminence. This is of clinical importance, for it determines whether function loss will be partial or complete, depending on whether or not these fibers are ruptured.

The lateral and medial vasti muscles send fibers insert into the lateral and medial aspect of the tibial condyles. The ruptures of the quadriceps tendon occupy two regions: (1) the *suprapatellar* region between the patella and the muscular portion of the *quadriceps femoris*; and (2) the *infrapatellar* region between the patella and the anterior tibial tuberosity. Of the tendinous ruptures, the quadriceps ruptures can occur on two sides. The more frequent condition is to have the rupture unilateral, and in the great majority of cases this occurs in the vicinity of the point of the patellar insertion. In twenty-one cases, Berger found the point of rupture to be

fourteen times at the superior border of the patella, twice 2 cm. above this point, and five times 4–5 cm. higher. In some cases, as

of the underlying structures. Our attention is to be focused first on the symptoms and signs occurring with fresh or recent injuries.

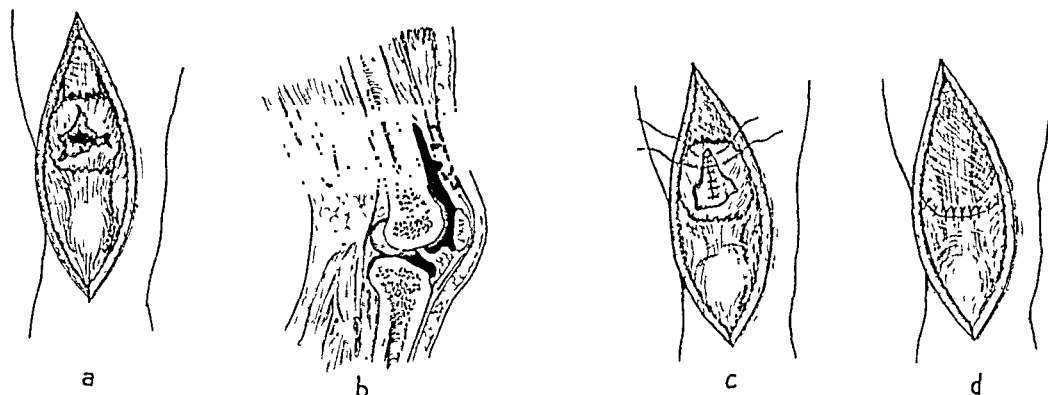


FIG. 3. Typical and common type of suprapatellar rupture and its repair. *a*, Rupture of the suprapatellar type revealing the extension of the rupture into the synovium with the attendant hemarthrosis. The quadriceps bursa has been torn. *b*, Sagittal view of the rupture disclosing the usual clinical findings with involvement of the three planes. It is to be noted that the planes are divided at different levels. The middle plane is divided at a higher level than the superficial plane. The deep plane is ruptured at a still higher level. *c*, The first stage in the operative repair discloses the synovium and the fibers of the vastus intermedius to have been brought together. This establishes the deep plane. In addition, two sutures have been placed in the torn ends of the decussating fibers of the vastus medialis and vastus lateralis in order to restore the middle plane. *d*, The final stage in the closure has brought the torn ends of the rectus femoris together with interrupted sutures. Several other sutures have been placed in the circumarthroidal tissues.

that of Poirier for example, the quadriceps and its fascia broke at different points; i.e., the tendon of the rectus femoris 4 mm. above the patella and the tendon of the vastus intermedius or crureus at 8 cm. above the patella. These ruptures may be limited to the rectus femoris entirely, or they may continue to include the vasti muscles which give rise to the lateral patellar aponeurotic expansions. When ruptures extend to the deeper planes, synovial lining becomes involved and the large hemarthroses are explained.

#### SYMPTOMATOLOGY

In describing the symptoms and signs encountered in the various types of rupture and in the varying degrees of ligamentous tear, one must first consider whether the lesion is a recent or an old injury. The signs and symptoms which are attendant upon this condition depend entirely on (1) the time and manner of occurrence of the accident; (2) the degree of separation of the fragment; (3) the extent of the laceration

The trilogy of symptoms of rupture of the quadriceps tendon at the moment of the fall are *pain*, *crepitus* and *function loss*:

- |               |   |  |
|---------------|---|--|
| Pain          | { | Is violent and immediate.  |
|               |   | Is compared to a sudden contraction of the muscles of the leg.   |
|               |   | Decreases with immobilization of the leg.  |
| Crepitus      | { | Reappears and increases with any movement of the leg.  |
|               |   | Is not necessarily a constant accompaniment.   |
|               |   | Is due to the sanguinous effusion which will be confounded after with crepitus due to fracture.  |
| Function loss | { | Power to extend the leg has gone.  |
|               |   | Walking on the plane surface is impossible. If walking is still possible, the high rupture of the tendon has not reached or entirely cut through the vasti muscles which relatively will supply some of the tendon deficiency. |
|               |   |  |

Examination of the extremity shows us the leg half flexed on the thigh. It is the position of rest for the joint and the sign of intra-articular involvement. It is likewise due to the tonicity and muscle spasm of the opposing group on the posterior aspect of the thigh no longer being compensated

by the pull of the quadriceps group. Somewhat rarely, as in our third case, there is ecchymosis at the point of contact where the injury is due to direct violence. (Fig. 5.) Hemarthrosis and the infiltration of the loose cellular tissue of the subcutaneous regions account for the swelling.

The pathognomonic physical sign of a suprapatellar rupture of the quadriceps tendon is the absence of the fullness due to the quadriceps pouch. This concavity or depression varies in depth with the extent of the rupture. It is only slightly marked if the anterior portion of the rectus femoris alone is torn. With an extensive laceration of the lateral expansions of the vasti muscles, one can visualize the superior aspect of the femoral condyles. The pathognomonic sign of complete infrapatellar ruptures is the shift upward of the patella. Hemarthrosis of the knee joint will *per se* indicate an injury extensive in type, for it has already involved the synovial lining of the joint cavity. X-ray of the knee joint and the anterior tibial tuberosity will

other traumatic intra-articular derangements may be excluded.

In old cases where disability has existed

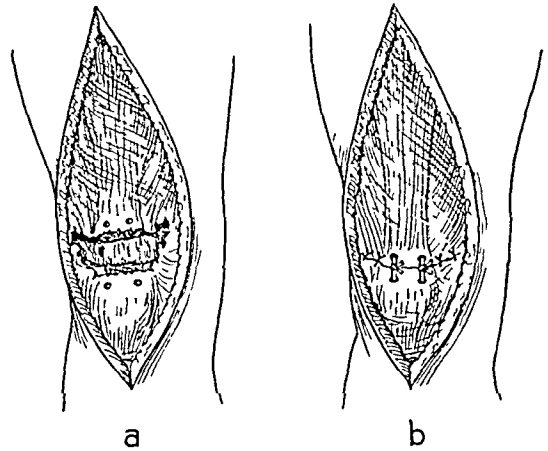


FIG. 4. Variation of the suprapatellar type of rupture. When rupture has also torn a fragment of the patella, the repair requires additional secure fixation. *a*, Demonstration of suprapatellar tearing with bone involvement. *b*, Repair of the bone defect by fixation to the corpus of the patella.

for a long time, the symptoms and signs are again dependent upon the type of rupture and the extent of the accompanying



FIG. 5. Case III. *a*, Shows preoperative appearance of the right lower extremity July 18, 1939. Power of extension is absent. The knee joint is swollen and ecchymotic and the normal markings are absent. Comparison with the unaffected extremity reveals the marked difference in the external configuration. The arrow indicates the local hematoma caused by the direct blow to the tibial tuberosity. *b* and *c*, Reveal the postoperative appearance with the patient being able to extend the leg. The old deformity of the foot is also shown. (Photograph taken September, 1939.)

demonstrate the degree of bone damage in those cases of infrapatellar damage with bone involvement, as in Case III. The differential diagnosis seldom becomes a problem of any great moment. From patellar fractures which might produce many similar clinical phenomena, the radiograph will clearly define the nature of the injury. Similarly, dislocations of the knee joint and

tissue damage. There is inability to extend the knee, with consequent decrease in power to climb any incline and lack of stability in ordinary walking on a level plane. This disability will vary in degree depending on the extent of muscle and tendon retraction and the involvement of the surrounding structures. The degree of quadriceps atrophy will also be a factor.

## TREATMENT

The treatment involved in the repair of the extensor apparatus is divided into two main groups:

- I. Treatment of recent injuries
  - (a) Nonoperative immobilization.
  - (b) Operative treatment.
- II. Treatment of late or old injuries
  - (a) Those cases which have not had previous operative interference.
  - (b) Those cases subsequent to previous operative repair.

The two fundamental objectives of all the technical procedures are first, the apposition of the ruptured parts and

Today the only cases regarded as non-operative entities are those incomplete musculotendinous or fibrillotendinous ruptures where function is good in spite of the injury. Even in these cases, unless some general contraindication exists, the operative repair offers a quicker, more certain and more complete end result. Motion may be started earlier and the possibility of quadriceps atrophy is reduced to a minimum.

For comparison, it will be of interest to review the treatment of the operative cases reported by Bull in 1889.

While it may seem trite to repeat that the successful operative treatment of quad-

TABLE IV

No.	Reporter	Sex and Age	Date	Manner of Injury	Treatment	Results
1	McBurney. <i>Ann. Surg.</i> , 6: 170, 1887.	Male 50	1885	Rupture near insertion into right tibia. Direct blow.	Suture of tendon with catgut. Retention suture of wire into tibia.	At eleventh week walked with cane. One year later, function perfect.
2	Lüning. <i>Corr. f. Schweiz. Aerzte</i> , 2: 689, 1881.	Male 18	1880	Tendon cut at insertion into patella. Butcher's chopper cut leg.	Suture of tendon with catgut.	Fifth month flexion of knee to 120°.
3	Wilkin. <i>New York J. Med.</i> , 28: 378, 1887.	Male 7	1887	Incised wound of thigh with cut tendon and an opening into joint.	Suture of tendon with silkworm gut.	At end of third month, flexion almost perfect.
4	Hartley. Personal communication.	Male 34	1888	Fall on knee causing suprapatellar rupture with fragment of superior border of patella ( $\frac{1}{2}$ inch $\times$ $\frac{3}{4}$ inch) contained in ligament.	Suture of tendon with wire fixation of patellar fragment and ligament to main portion of patella.	Result poor at end of third month. Very little power of extension.
5	Bull's case. <i>New York J. Med.</i> , pp. 421-424, April 20, 1889.	Male 59	1889	Fall on knee flexed with rupture of tendon $\frac{1}{4}$ inch above insertion into patella.	Suture with four chromic sutures.	Flexion to the right at end of three months. Extension to the horizontal plane.

secondly, the prevention of quadriceps muscle atrophy. All operations are preceded by the usual forty-eight hour skin preparation routine to all open extremity procedures.

riceps ruptures depends solely upon anatomic reposition of the component parts, an appreciation of this fact may be gleaned from the surgical anatomy of the area involved. For this reason no didactic out-

line of procedure may be postulated but general suggestions only are made.

**A. Recent Injuries.** 1. *Suprapatellar Rupture.* With the ruptures occurring in the musculotendinous portion (Fig. 1) as well as in that portion of the tendon midway between the superior patellar rim and the muscle, the immediate concern is to determine whether or not the knee joint has been entered. The presence of synovial fluid will, of course, indicate that the *vastus intermedius* or *crureus* which forms the posterior plane has been divided.

Repair begins with the synovial closure followed by the restoration of the interlacing of the decussating fibers from both the lateral and the medial vasti muscles. Subsequently, the tendinous portion of the rectus femoris is brought together. (Fig. 3.)

In that type of suprapatellar rupture which occurs near the superior edge of the patella with or without bone damage, the operator will have to determine for himself whether the case is one suitable for fascial suture plus fixation to the body of the patella. The employment of chromic catgut, silver wire, or kangaroo tendon depends entirely upon the individual operator's preference. The need for careful and secure apposition becomes evident when one considers the tremendous demands made upon this apparatus. (Fig. 4.)

The benefit of direct fixation of the tendon to the body of the patella can be realized when one appreciates the fact that the longitudinal arrangement of the fibers of the tendon permit easy tearing away of simple sutures.

II. *Infrapatellar Rupture.* With the infrapatellar ruptures the problem of securing tendinous fixation is evident. With ruptures involving the inferior patellar rim fascial or heavy catgut fixation plus drilling through the patellar substance appears to be the most satisfactory procedure. Ruptures occurring through the midportion of the tendon are not common, but do occur as in Wagner's case.<sup>101</sup> Avulsion of the most inferior portion of the tendon from the tibial tubercle with or without avulsion

of the bone demands direct fixation to the tibia. Case III of the author's falls into this group, and again, the choice of materials is an individual one.

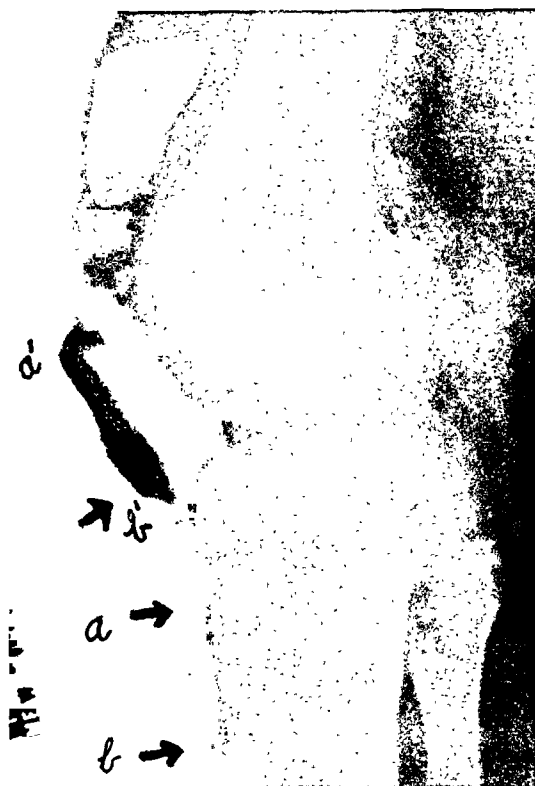


FIG. 6. Radiograph taken July 18, 1939, showing lateral view. The avulsed fragment, *a'-b'*, is shown, having been pulled superiorly from the portion of the tibial crest marked *a-b*.

**B. Repair of Delayed and Late Cases.** The treatment of delayed or late cases will depend upon whether or not the primary operation has been performed.

To the extent that a weak scar and muscle retraction exist extensor power will be limited. If the scar tissue begins to yield, the disability will increase, with corresponding increase in symptoms until extensor action has ceased. With quadriceps retraction, there is a tearing away of the adjacent circumarthroidal tissues. In this type of case, any attempt to describe didactically any specific type of operative repair is impossible.

The successful treatment of old cases depends upon four main factors: (1) ablation of all old cicatricial tissue; (2) restoration of the continuity of the ten-



don; (3) rehabilitation of the quadriceps muscle; and (4) absence of any intra-articular complications.

are due directly to (1) insufficient treatment, or (2) the local or general individual predisposing causes of the accident.

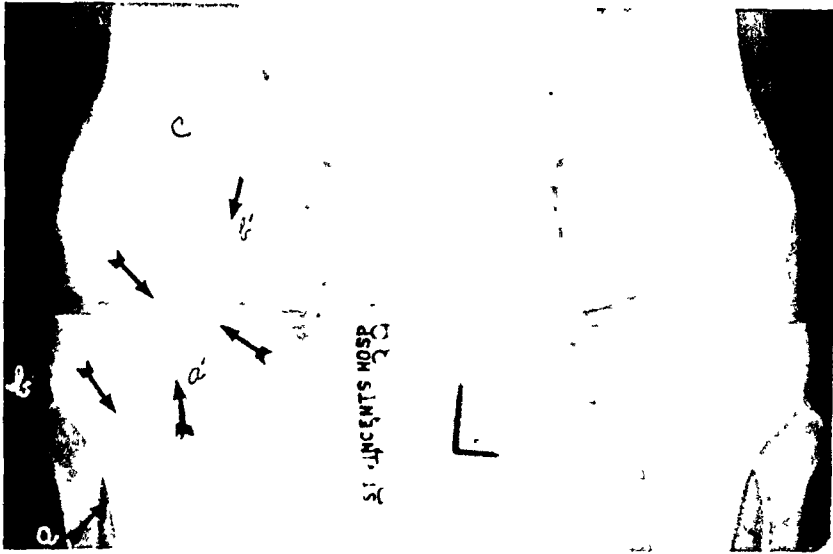


FIG. 7. View of the radiograph taken July 18, 1939, and a comparison with the unaffected extremity. Patella shown at (c) and the avulsed portion of the anterior tibial tuberosity, *a'-b'*, is indicated by arrows. The defect in the tibia is armed by *a-b*.

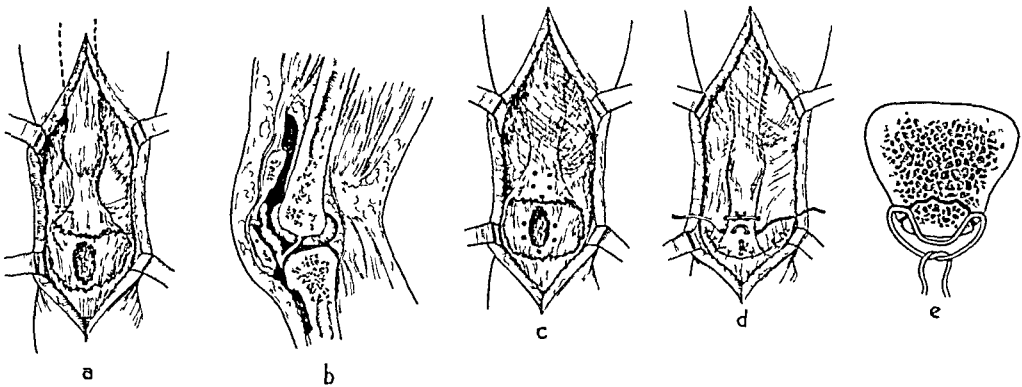


FIG. 8. Operative findings and the surgical repair employed in Case III, an infrapatellar rupture of the quadriceps tendon with avulsion of the tibial tuberosity. *a*, Operative findings showing the avulsed tibial tuberosity and the bed of the tibial crest from which it was torn. The patella is shown retracted superiorly. *b*, Lateral view of the operative findings showing the relative positions of the patella, the avulsed fragment and the portion of the tibia from which it was torn. *c*, First step in the repair of the rupture. The drill holes have been placed in both the avulsed fragment as well as around the portion of the tibia. *d*, The fragment has been replaced and fastened in such a way as to hold it securely. Three points of fixation are noted. In addition the expansions of the tendon are shown sutured with individual chromic sutures. *e*, Manner of placing drill holes and sutures so as to effect a double security of the avulsed fragment.

#### COMPLICATIONS

The complications encountered in this type of injury may be summarized briefly by stating that apart from the usual well known postoperative catastrophes, they

#### CASE REPORTS

**CASE I.** A white female, aged 40 years, was admitted to St. Vincent's Hospital December 7, 1935, after she had fallen while crossing the street. The accident was sudden and without

any apparent cause. Her past history was negative; a cholecystectomy had been performed in 1934. Physical examination was also negative except for the local condition of the left lower extremity. There was considerable swelling above and below the patella and an absence of the fullness which is normally due to the presence of the quadriceps bursa. Diagnosis was made of a ruptured quadriceps tendon in its suprapatellar portion.

X-ray examination of the knee showed evidences of soft part swelling above and below the patellar level as well as on the internal aspect of the knee, probably produced by the effusion. No other abnormalities were noted.

Eleven days after admission, following the usual forty-eight hour skin preparation, the tenorrhaphy was performed. At operation the tendon was found ruptured  $1\frac{1}{2}$  inches above its insertion into the superior margin of the patella. Considerable old hemorrhagic material was removed. The ruptured ends of the tendon were approximated with five No. 4 chromic sutures and plaster of Paris immobilization was applied.

The postoperative course was uneventful and the patient was discharged with wound healed and function satisfactory on January 10, 1936. After six months her condition was reported as excellent.

CASE II. T. D., aged 57 years, white male, was admitted to St. Vincent's Hospital January 30, 1934 following a fall down a staircase in which he had landed on the hyperflexed thigh. Following the accident he could not extend his right leg nor walk, and was brought to the hospital by ambulance. Physical examination was negative except for the local condition of the right lower extremity. The right knee was swollen and ability to raise the foot from the horizontal plane was lost.

X-ray showed considerable joint effusion. A small fragment of the superior aspect of the patella had been pulled upward for a distance of approximately 1 inch from the main body of the patella. Laboratory data were irrelevant except for evidences of coronary sclerosis.

At operation a suprapatellar rupture with a tearing away of some of the cortical surface of the patella was found. Repair was performed with kangaroo tendon and a plaster of Paris case applied.

The postoperative course was complicated by the presence of coronary sclerosis, but the

cast was removed on February 15, 1934 and the patient was out of bed two weeks later.

He was discharged in satisfactory condition March 5, 1934 and subsequent followup was favorable.

CASE III. C. M., 38 years old, white male, was admitted to the St. Vincent's Hospital on July 15, 1939, two days after an injury to his right knee, stated to have followed a direct blow over the right anterior tibial tuberosity. At the time of admission, there were several other contused areas. The patient was unable to extend his right knee and any attempt to move it caused excruciating pain. There was considerable periarticular swelling and ecchymosis and over the anterior tibial tubercle, a contused area  $\frac{1}{2}$  inch square was plainly visible. (Fig. 5A.)

X-ray examination revealed the avulsed fragment of bone attached to the insertion of the ruptured quadriceps tendon. The area from which the bone had been avulsed on the tibial crest was plainly visible. The torn end of the tendon was curled upon itself as were the bony attached fragments. (Figs. 6 and 7.) The patella had shifted upward to a considerable degree.

Repair of the avulsed quadriceps tendon was carried out, with fixation of the anterior tibial tuberosity. As a result of the direct blow over the anterior tibial tuberosity, this portion of the tibia was avulsed and with it the insertion of the quadriceps tendon.

The usual three day skin preparation for open operation was performed. A longitudinal incision was made lateral to the patella and was carried down to the crest of the tibia. Exposure of the tibial tuberosity revealed the avulsed portion of the bone containing fresh callus. The fragmented and torn portion of the quadriceps tendon was retracted upward and pinned on itself so that the entire infrapatellar portion of the quadriceps ligament had to be uncurled and replaced. Drill holes were then made around the avulsed cavity in the tibia. The avulsed tuberosity was then drilled in such a way as to permit double chromic No. 2 catgut to be placed and tied. (Fig. 8.) Three similar sutures were placed through the drill holes and tied over the tuberosity to keep the fragment in situ. Following this, lateral expansions of the quadriceps ligament were sutured and the entire infrapatellar portion of the quadriceps tendon, which was torn and jagged,

was sewed to itself with chromic No. 2 catgut. The joint capsule had been opened as a result of the original trauma and about 25 c.c. of bloody synovial fluid was removed at the time. The wound was closed in layers with chromic No. 0 and the skin closed with interrupted dermal sutures. A posterior moulded plaster splint which had been made prior to operation was then reapplied.

Diagnosis was infrapatellar rupture of quadriceps tendon with avulsion of the tibial tubercle.

The postoperative course was somewhat prolonged, owing to a superficial skin infection, but the posterior moulded Plaster of Paris splint was removed and the patient was allowed up on crutches on September 9, 1939. His power to extend his knee was excellent. (Figs. 5B and C.) At the time of discharge he could bend his knee to a right angle and extend it to the normal range. This man was given a follow-up examination on July 8, 1940, and the end result was regarded as satisfactory.

#### CONCLUSIONS

1. The varieties and types of ruptures of the quadriceps tendon are reviewed and classified.

2. The factors involved in the etiology and causation of this entity are examined.

3. Ruptures due to direct and indirect violence are discussed as are those of spontaneous etiology.

4. The pathologic anatomy involved in the varieties of rupture is discussed.

5. The trilogy of symptoms in cases of quadriceps rupture are pain, crepitus, and function loss.

6. The pathognomonic sign of suprapatellar rupture is the absence of fullness due to the quadriceps bursa.

7. The pathognomonic sign of infrapatellar rupture with or without avulsion of the tibial tubercle is an upward shift of the patella.

8. The treatment of recent injuries depends on the site of rupture, extent of laceration of the surrounding tissues, and the degree of function loss.

9. The successful treatment of late or delayed injuries will depend upon first, the ablation of all old cicatricial tissue; sec-

ondly, the restoration of the continuity of the tendon; thirdly, the rehabilitation of the quadriceps muscle; and lastly, the absence of any intra-articular complications.

10. The complications apart from the commonly encountered postoperative complications are due directly to (a) insufficient treatment and (b) the local or general individual predisposing causes of the accident.

11. Three operative cases are cited—two of which are suprapatellar ruptures and the third is an infrapatellar rupture with avulsion of the anterior tibial tubercle.

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# THE FALLACY OF THE CONJOINED TENDON\*

## THE ETIOLOGY AND REPAIR OF INGUINAL HERNIA

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SINCE the time of Morton<sup>1</sup> and Roustan,<sup>2</sup> the literature is replete with the importance of the conjoined ten-

tended more than  $\frac{5}{8}$  inch lateral from the insertion of the rectus muscle. Several recent publications<sup>10</sup> have emphasized the



FIG. 1. Dissection of inguinal region showing perfect conjoined tendon.

don in the repair of inguinal hernia. Bassini<sup>3</sup> in his method calls for the suturing of the conjoined tendon to Poupart's ligament. Halsted<sup>4</sup> required it, and many modern surgeons<sup>5-8</sup> following the same school utilize the conjoined tendon in the radical cure of hernia.

During the past eight years, the author has specially dissected the inguinal region of twenty cadavers. Of this number, only two specimens possessed a conjoined tendon definitely discernible as a distinct structure. In one of these bodies, the conjoined tendon (Fig. 1), was well defined on the right side, while a few fan-like strands represented the transversus abdominis muscle on the left. Blake<sup>9</sup> dissected twenty-five normal muscular subjects and found no instance in which the conjoined tendon ex-

wide structural variation present in this part of the body.

In view of these observations, the relative unimportance of the conjoined tendon either as a causative or a corrective agent in inguinal hernia has impressed me. It seems illogical to attribute properties to a structure so inconstant, and erroneous to incorporate it in the operative technique for the cure of hernia.

Confusion about the anatomic relations of the inguinal region makes the scientific understanding and repair of hernia impossible. The layers comprising this area are universally accepted as far as skin, superficial fascia, external and internal oblique muscles are concerned. Loose nomenclature of the remaining structure is partly to blame for the confusion. The abdomen pos-

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FIG. 2. Relationship of transversalis fascia to overlying structures.



FIG. 3. Note relation of conjoined tendon to other structures in inguinal region.



FIG. 4. Defective transversalis fascia with penetration of a lipomatous body through rent (a direct hernia).

sesses a third muscular layer, a distinct entity, always present, but at times thin and not uniform in its extent. This layer extends over the lateral abdomen down to the anterior-superior iliac spine, with fibers directed transversely. For this reason, the correct nomenclature properly regards this structure as the transversus abdominis muscle. It must be emphasized that this muscle is a definite entity and should not be confused with the strong, entirely aponeurotic layer lying beneath it, however intimate and entwining the fascicles. The transversus abdominis is muscular in its lateral portion and tendinous in its medial aspect, like the overlying internal and external oblique muscles. The transversalis fascia, however, is entirely aponeurotic, lies beneath all the above-mentioned structures, and has connection with the transversus abdominis muscle only by contiguity. (Fig. 2.) To call the transversus abdominis the transversalis muscle is obsolete, and begets ambiguity.

Where extant, the tendinous portion of the transversus abdominis muscle comes in contact with the lateral portion of the internal oblique muscle several centimeters above the pubic spine. This continuity is termed the conjoined tendon. (Fig. 3.) We repeat: *where such a structure exists.*

With these anatomic landmarks defined, our attention is directed to the consideration of the etiologic factor productive of a hernia.

Considering a hernia as a protrusion of a viscus through any part of the abdominal parietes, it is evident that the first layer immediately adjacent to the peritoneum must be defective or penetrated before the abdominal contents can escape. It is, in our opinion, to this layer that we must ultimately resort for an answer to the question of etiology and repair of hernia. An intact, strong, resisting transversalis fascia is incompatible with a hernia. Here is nature's first line of defense. No other single structure can replace it. Destroy its continuity, relax its aponeurotic plan, and you have potential pathology. (Fig. 4.)

Lack of uniformity in opinion regarding the distribution of this fascia arrests progress in the surgical understanding of hernia.

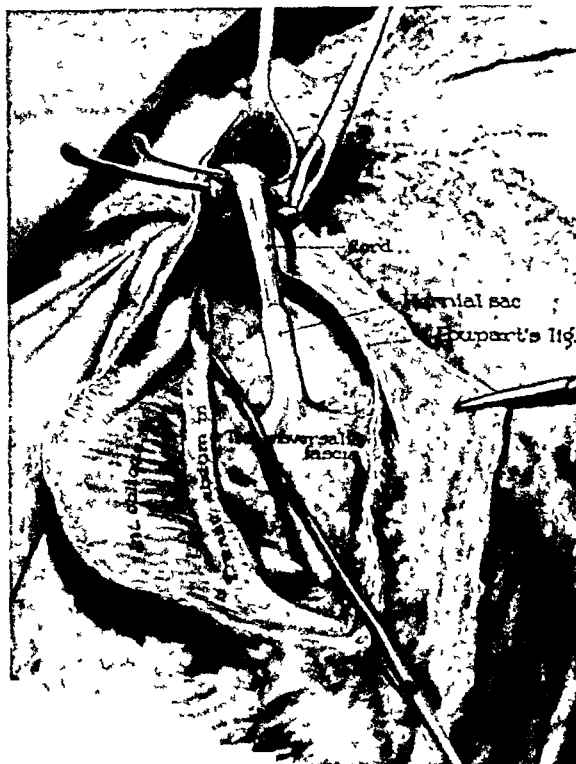


FIG. 5. Indirect hernia with infundibuliform fascial sac. Note relation of infundibuliform and transversalis fascias.

That the transversalis fascia plays an important rôle in the structure of the inguinal canal, everyone admits. The fact that the internal inguinal ring and the infundibuliform covering of the cord are part of that same fascia is, however, ignored. (Fig. 5.) The surgical floor of the canal is only a part of the broad aponeurotic sheath extending from Poupart's to Poupart's down to the symphysis pubis. The so-called "weak spot" is not attributable to a defective conjoined tendon, but rather to a badly relaxed or torn transversalis fascia. (Fig. 6.)

The etiology of direct hernia is clear. The simple closure of this defect by suture constitutes adequate repair for such a hernia, irrespective of what is done with the overlying structures by way of reinforcement. No matter how ingenious the latter, neglect of the former will produce disappointment.

The structures lying upon the transversalis fascia are not to be discarded as un-



important. Utilization of every available tissue is paramount. The present contention emphasizes the structure which rightly

of chromic catgut or fine silk, and attached to the shelving edge of Poupart's ligament. (Fig. 7F.) Thus a second internal inguinal



FIG. 6. The so-called "weak spot" in the transversalis fascia.

should receive foremost consideration in any planned herniorrhaphy.

In indirect hernia of the cord, the importance of the transversalis fascia cannot be overestimated. A short inguinal ligament,<sup>11,12</sup> a defective, overlapping, internal oblique muscle,<sup>11,13</sup> or a relaxed external ring<sup>14-16</sup> may influence the appearance of the pathology. These are extraneous things, however; they are accidents which do not pertain to the essential causative principles in this type of hernia.

An anatomically perfect transversalis fascia comprising the internal inguinal ring is inconsistent with a hernia of the cord. (Fig. 7A.) On the other hand, the repair of this hernia, after the dissection, isolation, ligation and excision of the sac (Fig. 7B and C), involves the reconstruction of the internal inguinal ring. This may be accomplished adequately by a single purse-string suture that includes, besides the fascia, a bit of the cord and Poupart's ligament. (Fig. 7D and E.) The rent in the transversalis fascia is closed by interrupted sutures

ring is created at the most distal part of the canal without grave interference in the morphology of this structure. The reconstruction of the external ring is accomplished by fascial imbrication of the lateral margin of the external oblique over to the fascia of the internal oblique, using a continuous chromic catgut suture. (Fig. 7G.) The operation is completed by superimposing the medial margin of the external oblique upon its lateral surface by means of the same continuous stitch. (Fig. 7H.)

#### SUMMARY

Many methods of hernial repair and their modifications have been devised. With some trepidation, the present one is submitted because of its anatomic soundness. This repair takes cognizance of the structural relationships in this part of the body without gross disturbance to their physiology.

The author acknowledges his indebtedness to Dr. Reuben Gaines for taking the candid camera illustrations.

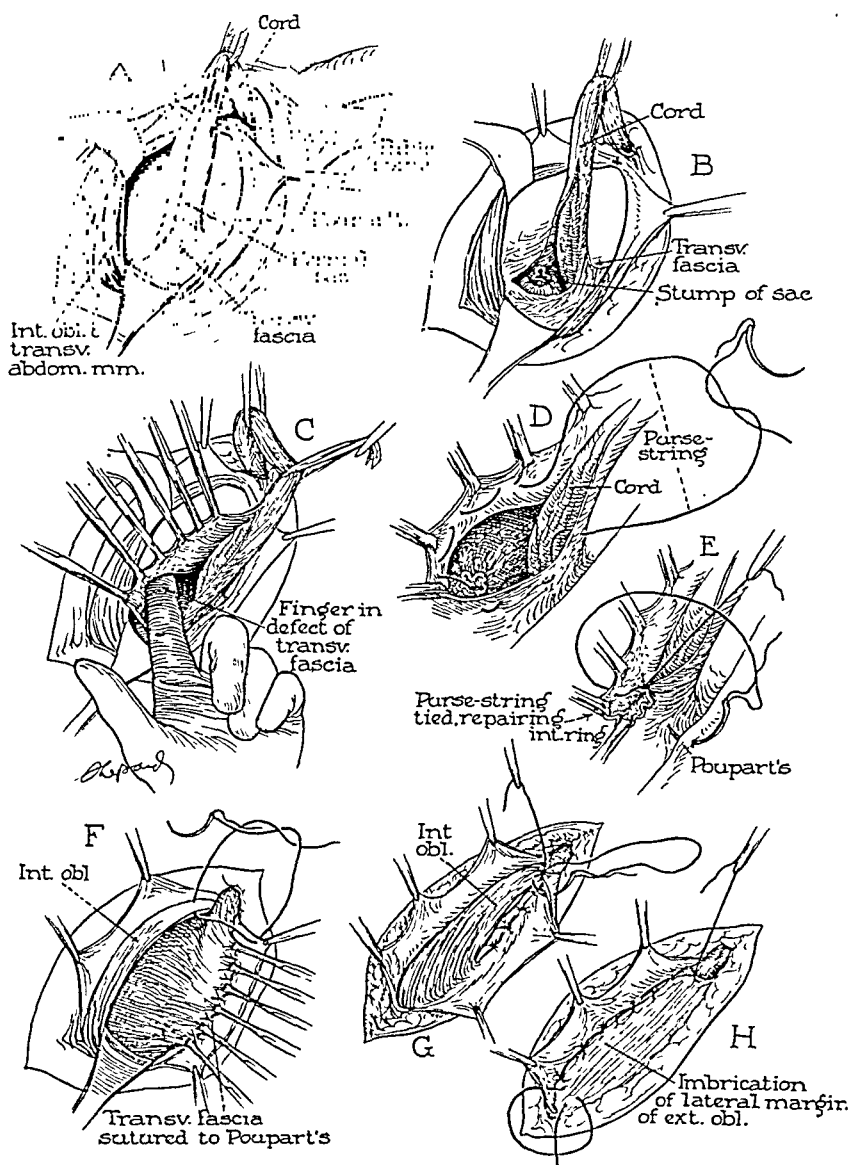


FIG. 7. Successive steps in author's method of repair for indirect inguinal hernia.

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# THE SURGICAL IMPORTANCE OF ACCESSORY SPLEENS

## WITH REPORT OF TWO CASES

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**A**CCESSORY spleens are uniformly described by anatomists, frequently seen by the pathologist in the autopsy room, but seldom noted by the surgeon at operation.

A review of the literature reveals comparatively few cases in which surgical conditions were occasioned directly by the presence of accessory spleens. The majority of the reported cases have produced subacute or chronic manifestations clinically. However, acute pathologic changes may occur in intra-abdominal accessory spleens and give rise to acute surgical emergencies, in which the clinical signs and symptoms are those of an "acute surgical abdomen" of obscure etiology. This fact is well illustrated by the two cases here reported.

**CASE 1.** S. G., a 4 year old male child, was admitted April 20, 1935 with a chief complaint of generalized abdominal pain. This had begun three days prior to admission and had been followed by nausea and vomiting. Twenty-four hours later the child developed chills and fever. There had been no bowel movement for twenty-four hours. The past history was unimportant, except that for two years the child had occasionally cried with abdominal pain.

Physical examination revealed an acutely ill child crying in pain. The temperature was 102.4 degrees rectally, the pulse 120 beats per minute. The skin was dry. The abdomen was quite distended and tympanitic, with moderate rigidity and tenderness throughout and the point of greatest tenderness was in the left upper quadrant. Peristaltic sounds were not audible. The liver, spleen, and kidneys were not enlarged and there were no palpable masses.

The laboratory examination was not remarkable except for a leucocytosis of 21,000 with 92 per cent neutrophils.

Roentgen examination by barium enema revealed an extrinsic filling defect and deformity

of the colon at the splenic flexure with gaseous "distention" and "staircase" effect in the proximal loops of small bowel.

Eight hours after admission the abdomen was opened through a left rectus incision. About 300 c.c. of cloudy, straw colored fluid was present free in the peritoneal cavity. Several fibrin covered loops of small bowel and the colon at the hepatic flexure were adherent to an orange-sized mass in the left upper quadrant, the kinking producing an obstruction in the proximal small bowel. The loops of bowel were dissected away revealing an encapsulated tumor mass attached by a 2 inch pedicle, the base of which sprang from the gastrosplenic ligament. The mass was quite soft and covered with fresh fibrin, evidence of acute inflammation. This was due to torsion of the pedicle producing a complete strangulation. The pedicle was ligated and the mass removed in toto. The spleen was palpated and found to be of normal size, shape and position. The abdomen was closed without drainage and recovery was uneventful.

The specimen was an encapsulated tumor mass, ovoid in shape, measuring 6 by 6 by 7 cm. and weighing 125 Gm. At its base there was a thick fibrous pedicle stump, ligated close to the capsule. (Fig. 1.) Elsewhere the capsular surface was quite smooth except for numerous old and recent fibrous tags, evidence of adhesion to adjacent structures. The capsule 2 mm. thick was covered with flaky fresh fibrin. The cut surface of the mass presented a deep red appearance, with numerous interlacing fibrous trabeculae and many small islands of soft gray tissue. The consistency was extremely soft. The parenchyma everted above the cut surface. (Fig. 2.)

Sections showed a general architecture identical with that of splenic tissue. The capsule was quite thickened and covered with polymorphonuclear leucocytes and fibrin. Fibrous trabeculae extended from the capsule into the parenchyma. The pulp was densely infiltrated with polymorphonuclear neutrophils, the si-

nuses stuffed with erythrocytes. Extensive areas of hemorrhage and necrosis were present and splenic nodules were numerous. The patho-

quadrant which was covered with folds of omentum anteriorly. The mass was delivered into the wound, the early cobweb-like adhesions



FIG. 1. External surface of accessory spleen showing pedicle stump.



FIG. 2. Cut surface of accessory spleen, showing fibrous trabeculae, germinal centers and soft pulp.

logic diagnosis was complete infarction of an accessory spleen.

CASE II. H. C., an 8 year old female, January 14, 1937 complained of abdominal pain. The illness had begun about eighteen hours prior to admission when the patient was awakened from sleep by epigastric pain sharp and constant in character. A few hours after onset it became localized in the mid-abdomen. Emesis occurred about thirty minutes after onset and had continued at infrequent intervals. The past history was irrelevant.

The child lay flat in bed and was moaning with pain. The temperature was 99.6°F. orally, the pulse 100 beats per minute. The abdomen was flat. There was slight tenderness to palpation over the entire anterior abdominal wall, most marked over the left upper quadrant to the left of and above the umbilicus. Moderate rigidity was present in this area but absent elsewhere. An indistinct, tender, movable lemon-sized mass was palpable in the left upper quadrant three fingerbreadths below the left costal margin. The kidneys, spleen or liver were not palpable. The extremities and the reflexes were normal.

The only significant laboratory finding was a leucocytosis of 13,000, the distribution being within normal limits.

A flat film of the abdomen showed no abnormality and examination of the colon by a barium enema revealed no deformity or filling defect.

Laparotomy was performed six hours after admission. The abdomen was opened by a high left rectus incision. The exploring hand immediately encountered a mass in the left upper

quadrant with the omentum were separated with ease and the pedicle of the mass was doubly ligated and amputated close to its base at the left lower border of the gastrocolic ligament. The pedicle was composed of delicate fibrous fatty tissue and the vessels contained therein, which formed the blood supply to the tumor, were quite dilated and tortuous. The encapsulated mass was quite tense, the distal portion of the pedicle slightly inflamed, and it was thought that the signs and symptoms were definitely due to torsion of the mass on the pedicle.

The mass was spherical and encapsulated, 2 by 3 by 3 cm. in size, and attached to a thin loose fatty connective tissue pedicle 3.3 cm. in length. The capsule was covered with several fibrofatty tags. The cut surface had a deep reddish purple appearance.

The histologic appearance was identical with that of splenic tissue. The sinuses were congested with erythrocytes. Many lymphoid cells and a moderate number of polymorphonuclear leucocytes were scattered through the reticulum.

The pathologic diagnosis was mild acute splenitis in an accessory spleen.

A careful search of the literature does not show a case report in which an accessory spleen reached the size of that in Case I. No doubt the size was considerably increased by the duration of the acute inflammatory process. However, the finding bears out generally the contention that accessory spleens are larger in infancy and early childhood. Since the incidence is greater in this age group, it is surprising

that the great majority of the reported cases in which clinical manifestations occurred have been in adults.

**Diagnosis.** Since torsion of an accessory spleen on its pedicle constitutes by far the most frequent cause for surgical interference, and because the correct diagnosis was established preoperatively in but one instance (Alexander) among those cases reported, the diagnostic findings should be considered. The diagnosis is usually obscure. As in the cases here reported, vague abdominal pain—with or without fever, nausea, vomiting, leucocytosis or partial intestinal obstruction—plus the presence of a tender mass in the region of the pain, sometimes accompanied by muscular rigidity and abdominal tenderness, should at least suggest this condition.

**Clinical Manifestations.** It is only recently that the clinical importance of the accessory spleen has been emphasized, since it seldom gives rise to symptoms.

Accessory spleens may produce clinical manifestations not only by (1) mechanical interference, but also (2) by inflammation, (3) by neoplastic change, and (4) by compensatory hypertrophy following primary splenectomy.

1. Mechanical interference may be produced by torsion on the pedicle, as in the cases reported above, or by pressure symptoms due to enlargement, interfering with intestinal peristalsis or giving rise to actual intestinal obstruction.

Alexander and Romanes report the case of a 25 year old female with recurrent attacks of unexplained upper abdominal pain in which laparotomy revealed an accessory spleen attached to the greater omentum and producing symptoms by torsion on its pedicle.

Alexander later reported a similar case of a 35 year old housewife with recurrent attacks of pain in the left upper quadrant and an intermittently palpable movable mass in this area. Laparotomy revealed an accessory spleen attached to the gastro-hepatic omentum by a 3 inch pedicle. Removal was followed by complete recovery.

Temoin describes the case of a 35 year old female who complained of a painful lump in the abdomen for eighteen years. Laparotomy revealed an accessory spleen in and beneath the omentum with adhesion of numerous loops of small bowel, producing symptoms by kinking and interference with mesenteric circulation.

In Voss' case, the patient complained of increasing attacks of pain in the left hypochondrium for several years. At laparotomy, an accessory spleen was found on the anterior surface of the transverse colon 2.5 cm. from the splenic flexure. Symptoms were due to interference with peristalsis.

2. Inflammatory lesions. Accessory spleens may undergo inflammatory changes identical with those occurring in the primary spleen. During the acute infectious diseases, the changes producing acute splenic tumor may be coincident in accessory organs. A case was called to the author's attention in which a painful enlargement of the scrotum of an adult male occurred during the acute febrile course of a tertian malaria. An enlarged accessory spleen was found in the scrotum at operation.

3. Neoplastic lesions. Accessory spleens may undergo neoplastic change. In the leucemias they may take on the changes usually found in the primary spleen. They may be involved simultaneously with the spleen in the lymphoblastoma group.

4. Compensatory hypertrophy. Accessory spleens may hypertrophy following primary splenectomy; this fact, as pointed out by Curtis and White, is of great surgical significance. If they are left behind at operation they may subsequently enlarge and the symptoms for which the original splenectomy was performed may recur. Morrison, Lederer and Fradkin report a case of essential thrombocytopenic purpura in a 21 year old female where splenectomy was done, but a walnut-sized accessory spleen which was found at the time of operation was not removed. Following operation immediate improve-

ment occurred but was followed by gradual recurrence of the disease to the preoperative level. It was thought the presence of the accessory spleen accounted for the recurrence of symptoms. These authors argue that a small primary spleen is apt to be accompanied by additional compensatory splenic bodies.

Warthin and Mayo (quoted by Alexander and Romanes) contend that if the primary spleen is functionally or structurally deficient there is a compensatory hyperplasia of accessory splenic tissue. Thus it would appear timely to search for and remove accessory spleens at the first operation. In any case of essential thrombocytopenic purpura or congenital hemolytic icterus where symptoms recur following splenectomy, the possibility of regeneration of an accessory spleen should be considered.

Accessory spleens occur with comparative frequency (10 to 35 per cent) in the abdominal cavity; more rarely in the scrotum, liver and pancreas. Intra-abdominal accessory spleens occur with greater frequency in childhood.

The number of accessory spleens described in individual cases varies from one or two to 1000.

The location of accessory spleens varies. According to Schilling, the most frequent sites are: (1) hilus of the spleen; (2) gastrosplenic ligament; (3) splenocolic ligament; (4) great omentum; (5) pleurocolic ligament; (6) peritoneal tissue along the great splenic vessels, (7) pancreas. Hempelmann describes the lesions as "usually a small bud of splenic tissue situated between the peritoneal folds near the hilum, but they may appear in any part of the abdominal cavity."

Accessory spleens generally vary in size from 2 or 3 mm. up to 4 cm. in diameter. They are encapsulated and of the color and consistency of normal spleens. They may be sessile or pedunculated, and in the latter case one or more smaller bodies are frequently found lying within the pedicle of a larger.

The accessory spleen is an anomaly. It occurs following trauma or as a result of a developmental abnormality in embryo.

#### SUMMARY

Two cases in which acute surgical emergencies were produced by torsion of an accessory spleen on its pedicle are presented. The importance of accessory spleens to the clinician and surgeon is emphasized. They may produce clinical manifestations by mechanical interference, by inflammation, by neoplasia or by compensatory hypertrophy following primary splenectomy. Accessory spleens occur with comparative frequency in certain locations in the abdomen and scrotum, rarely in the pancreas and liver. Their presence may be accounted for by trauma to the primary spleen with subsequent transplantation of splenic tissue or by developmental changes in embryo.

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STERILITY of the operative field is impossible to obtain in surgery of the rectum and anus except in a few operations which are performed through a perianal skin incision without entering the bowel lumen.  
From—"The Rectum and Colon" by Hayden (Lea & Febiger).

# OPERATION FOR GREATER MOBILIZATION OF THE TRANSVERSALIS FASCIA IN THE REPAIR OF DIRECT INGUINAL HERNIAE

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THE importance of the transversalis fascia in the repair of direct inguinal herniae has long been recognized and many procedures described to utilize it to its fullest extent. In direct inguinal herniae, however, the ruptured fascia is so frayed and thinned out that attempts to suture it together or to suture it to other structures are not very efficient. It is particularly difficult in a direct hernia of any size to identify this attenuated ruptured fascia.

Since 1933 an operation has been used for all direct herniae, which utilizes a strong, well developed band of fascia, formed by the fusion of transversalis aponeurosis and transversalis fascia. This is obtained by splitting longitudinally the internal oblique muscle and pulling this fascial band, which is particularly developed, through the muscle and suturing it to Poupart's ligament. The new fascial floor of the canal extends from the level of the pubic spine to just below the lower edge of the cord as it emerges from the internal inguinal ring. This firm fascial layer is then supplemented by the Bassini closure.

In this operation the usual skin incision is made. The aponeurosis of the external oblique is opened and reflected, exposing the cord beneath the cremasteric muscle. An indirect sac is found by incising the cremasteric muscle and infundibuliform fibers of the transversalis fascia. The indirect sac is isolated and opened and the direct sac pulled up beneath the epigastric vessels, converting it into the indirect sac, according to the maneuver of Hognuet. This is then transfixed and reduced in the usual way. The cord is retracted inward

by two small retractors and the distinct shelving edge of the transversalis muscle is identified beneath the overlying internal oblique muscle.

With a blunt-pointed scissors or a hemostat, at about the upper middle, midway between the pubic spine and the internal inguinal ring, the internal oblique muscle is perforated and widely split longitudinally about 1 cm. from its margin down to the aponeurotic fascia. This is done by opening the blades of the scissors. The fascia is recognized as a glistening white fascial band with longitudinal striations. It is grasped with a forceps and pulled through the muscle and, by gentle traction and the addition of other forceps, is freed from the overlying musculature and separated by blunt dissection from just below the emergence of the cord at the internal ring down to the pubic spine. The outer edge of the longitudinally split muscle is allowed to drop below the fascia, the fibers of which, together with a few of the split fibers of the internal oblique which may be included in the distal portion of the muscle, by a reparative fibrosis, add to the subsequent strength of the repair.

The transversalis fascia and aponeurosis is sufficiently mobilized by pulling downward and outward towards Poupart's ligament until, without any tension whatever, it overlaps the edge of the ligament. The broad, strong fascial band, which has been pulled through the outer margin of the muscle, is then sutured to the ligament by interrupted silk sutures from just below the level of the cord as it emerges from the ring. The sutures should be placed about 1 cm. apart and should firmly overlap the edge of the fascia on Poupart's ligament. This can



be carried down, in a majority of cases, to the level of the pubic spine without any tension.

In about 20 per cent of the cases the lower portion of the transversalis aponeurosis and fascia is so fused with the ligamentous portion of the internal oblique forming the conjoined tendon that it cannot be separated all the way to the spine without tension, but in the vast majority of cases it forms a thick, distinct, well developed fascial layer to the pubic spine.

Care must be taken in inserting the suture *not to press too closely to the cord*, as there is apt to be tension in the upper portion. If the cord is impinged upon, circulatory changes may result in atrophy of the testicle. It is important that none of the sutures be under tension.

The wound is closed in the usual manner, following the Bassini method. The remains of the conjoined tendon, transversalis muscle and internal oblique muscles are approximated and sutured to Poupart's

ligament, care being taken to place these sutures between the previous ones, thus preventing any possible hiatus of the fascia. The sutures not only include the muscle, but pick up also the edge of the fascia as it overlaps Poupart's ligament. These are carried in the usual manner through Poupart's ligament, with transplantation of the cord. By this procedure the direct space is well closed by an extra fascial layer of unusual strength. Silk technique is employed in closure.

#### CONCLUSIONS

This procedure has been used in approximately 400 cases, which have been followed by check-up inspections since 1933. There have been six recurrences, of which three have been reoperated, giving a recurrent rate of about 1.5 per cent. The number of cases is too small and the time elapsed too short to give complete end results, but the procedure seems rational and effective.



# LOBECTOMY FOR BRONCHIECTASIS\*

## REPORT OF TWO CASES

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THE groundwork for the more recent progress in the treatment of bronchiectasis, a hopelessly progressive disease which ultimately totally incapacitates, can be attributed to the combined efforts of the clinician, the bronchoscopist, the roentgenologist, the anesthetist and the surgeon. A voluminous literature records the efforts of earlier investigators who laid the foundation for every phase of the subject. No longer need the clinician look with despair on the outcome of surgery. The early recognition of the disease, and the realization of the limitations of conservative therapy should prevent metastases in the brain or kidney and possibly limit simple bronchiectatic suppurations before they become septic, with the obvious increased surgical hazards.

Factors of undisputed importance in the reduction of the mortality from surgery are: the utilization of the more recent developments in accurate diagnosis, especially after the instillation of iodized oil into the bronchial tree; preoperative postural and bronchoscopic drainage; supportive treatment such as transfusions; improvements in anesthetic agents and their administration; and the use of the oxygen tent postoperatively in diminishing anoxemia. Factors of a possibly controversial nature, which have in the hands of different investigators given variable results, include: the proper evaluation of the rôle of pneumothorax; the creation of adhesions to immobilize the upper lobe to limit infection and facilitate lobectomy; and the choice of a one- or two-stage operative procedure. These achievements are evidence of a wide participation of many investigators in the development

of the surgical therapy. It is now generally recognized that lobectomy or pneumonectomy is the only method of treatment that permanently relieves the patient of this disease.

*Etiology.* Residual chronic infections of the respiratory tract superimposed on a mild influenza, measles, scarlet, whooping cough and pansinusitis, or the aspiration of a small foreign body are causative factors which often lose their significance because of the comparative mildness of the symptoms. These may be present for many years before the underlying morphology is appreciated. In the second case reported here, the onset of symptoms dated back seventeen years to a protracted "bronchitis." Numerous observers noted the frequency with which the inception of the disease could be traced to a comparatively early age and commented on the span of years before disease was properly evaluated and corrective measures instituted.<sup>14</sup> Bohrer<sup>3</sup> states that 50 per cent of adults with bronchitis date the genesis of their disease to childhood.

Smith<sup>5</sup> stresses the importance of fusospirochetæ in the diseased mouth as a source of infection. He commented on the large percentage of cases of pulmonary suppuration attributable to these organisms.

Watson and Kibler<sup>6</sup> reported a definite association of allergic diseases in 90 per cent of the cases of bronchiectasis under their observation in Arizona. They noted the frequency with which patients with allergic nasal trouble and sinusitis had a coexisting bronchiectasis and in whom the bronchial secretions presented an abnormally high percentage of eosinophiles. They

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quote Hansel<sup>7</sup> as having found allergic manifestations and abnormal amounts of eosinophiles in the nasal secretions in 44 per cent of patients seeking relief for nasal trouble.

**Diagnosis.** Importance factors influencing the course of treatment and the prognosis are the interpretation of the results of the various diagnostic procedures utilized in determining the presence and the extent of the bronchiectasis.

(a) *Bronchoscopy*<sup>8</sup> will exclude the presence of a foreign body or tumor. It will also determine the presence of narrowing or occlusion and the precise source of the expectoration.

(b) *Bronchography*.<sup>9</sup> The instillation of iodized oil in both bronchi and their tributaries will accurately determine the extent and distribution of saccular or cylindrical dilatation. Instillation of lipiodol in the upper lobes should be done by means of a catheter under the guidance of the fluoroscope on a tilt table. By this means other pulmonary diseases can be excluded, particularly tuberculosis, abscess of the lung or the presence of a new growth.

(c) *Cytological Examination.* Uncontaminated secretions obtained on aspiration by means of the bronchoscope should be cultivated for bacteria and spore-bearing anaerobes. Smears of the secretion stained with gentian violet or dilute carbol-fuchsin as suggested by Smith<sup>5</sup> should be examined for the fusiform bacilli and thicker spirochetes (*Treponema buccale* and *Treponema vicienti*). The bronchial and nasal secretions should be examined for eosinophiles to establish possible allergic background.<sup>6</sup>

(d) Cutaneous allergic tests should be carried out.

(e) Accessory sinuses should be radiographed for cloudiness. Its possible allergy should be borne in mind.

**Classification.** Before the methods of treatment can be evaluated, numerous basic factors having a direct bearing on the ultimate outcome must be considered. The lowest mortality has been reported in

the comparatively dry nonputrid cases. The septic and putrid cases of bronchiectasis have accounted for the higher mortality because of the obviously increased surgical risk. The age of the patient, the duration of the disease, the extent of the infectious process, the extent of parenchymal pneumonitis, coincident abscess, the febrile state and character and amount of sputum, all have a direct bearing on the ultimate result of any method of therapy.

Every sufferer with bronchiectasis should be classified in a distinct group to standardize, if that is possible, a method of approach to the problem, that would lessen the precariousness of surgery. Archibald's<sup>10</sup> grouping into three classes is an arbitrary one into which most of the patients can be fitted from both a therapeutic and a prognostic standpoint. Briefly, Archibald's aseptic or dry group includes those cases of chronic bronchitis in which lipiodol filling shows cylindrical dilatation without evidence of abscess. These patients cough a moderate amount of mucoid or mucopurulent sputum and are generally afebrile. Early recognition of this group by bronchoscopy and bronchography will exclude cases of tuberculosis, asthma, bronchitis, and unresolved pneumonia. Surgical treatment in this group has been attended with the lowest mortality. The second group of patients includes those distressed by cough, with drainage of a fair amount of foul sputum. Pneumograms reveal small cylindrical fusiform sacculations, thickened parenchyma but no clearly defined abscess. Fever accompanies retention of secretions. This group may border on the third class if complicated by pleurisy or empyema. Such patients may be semi-invalided for years with wide variations of disability or they may get worse and pass into the third class. Patients in this third group suffer from chronic sepsis, are frequently febrile and dyspneic on exertion. They may also cough frequently, have foul and abundant sputum and tend to show clubbing of the fingers. The x-ray reveals a diffuse shadow of unresolved pneumonitis, with thickened pleura

from empyema which has drained and healed. Lipiodol studies show cylindrical fusiform and saccular dilatation with frequent abscesses. Drainage of expectoration is free but not adequate. Archibald stresses the situation of this type of patient who has frequently had postural and bronchoscopic drainage, with climatic treatment. They come to the surgeon in a precarious condition so that lobectomy is attended with a high mortality. Obviously there is no sharp line of demarcation in these groups. The prognosis is best in the first class and becomes more grave as the patient becomes septic and the lung becomes putrid. Archibald doubts the validity of lobectomy in the first group unless the condition is aggravated as a result of an intercurrent pneumonitis such as to bring these patients into the second class.

*Treatment.* Effort should be made to exclude the association of nasal allergy causing a basal allergic bronchitis.<sup>6</sup> Where evidence of fusospirochetal infection is present, treatment with arsenical preparations should be instituted.<sup>5</sup> The use of large doses of radiotherapy to affect the secreting mucous membrane has been reported by Berck and Harris;<sup>11</sup> great improvement followed in a considerable number of the thirty cases so treated.

Failure to influence the disease favorably by rest, postural and bronchoscopic drainage, radiotherapy, intravenous therapy with neoarsphenamine, vaccine therapy or by a change in climate justifies serious consideration of surgery. Waiting until a comparatively dry bronchiectasis develops some intercurrent infection which will activate the disease and probably render the case septic or putrid enhances the difficulties of surgery and may be followed by grave consequences. Further procrastination may result in spreading to other parts of the same lung or to the contralateral lung. Complications such as recurrent pneumonia, pulmonary abscess, empyema, cerebral or kidney abscess may develop. It is generally conceded that lobectomy or pneumonectomy offers the only permanent relief

for patients suffering with bronchiectasis who have failed to respond to conservative therapy.

*Choice of Operative Procedure.* The advantage of the choice of one- or two-stage procedure is still the subject of discussion and contention. Each case should be treated on its individual merits. Bohrer<sup>3</sup> collected forty-one cases in children, with a mortality of 34 per cent after lobectomy; twenty-three patients had a lobectomy in one stage, with 39 per cent mortality, and sixteen in two stages, with a 40 per cent mortality. In his own series of five cases, four had a two-stage and one a one-stage operation; four lived and one died. Lanman<sup>4</sup> reported ten cases in children, seven lobectomies and three pneumonectomies, all in one stage, with an operative mortality of 10 per cent. There are numerous advocates of the one-stage operation of Lilienthal<sup>12</sup> and Brunn,<sup>13</sup> and an equal number favoring Alexander's<sup>14</sup> two-stage procedure.

It is generally contended, that if the upper lobe could be fixed by adhesions to the chest wall, the extent of both infection and respiratory embarrassment would be limited and the hazards of lobectomy would be appreciably lessened. Graham's<sup>15</sup> objection to Alexander's method of creating adhesions by wiping the visceral and parietal pleura with gauze, is that this results in excessive fixation of the lung to the chest wall and obliteration of the interlobar fissure. The numerous methods to create adhesions for anchoring the upper lobe to the chest wall have not all been uniformly satisfactory.

Bethune<sup>16</sup> has advocated the use of  $1\frac{1}{2}$  per cent iodized talc powder. Under thorascopic guidance in a closed pneumothorax this is blown on to the surface of a partially collapsed upper lobe by means of a powder blower.

Churchill<sup>17</sup> contends that a middle ground should be taken and that the chief virtue of a two-stage operation is the limitation of infection to a small pleural cavity. He believes that a two-stage operation is

easier and in the presence of a free pleural cavity there is less septic convalescence.

The two patients reported in this paper



FIG. 1. Case 1. January 10, 1934, bronchoscopic instillation with lipiodol, showing a compressed right bronchus with a large, wing-shaped shadow extending obliquely forward and outward and the other wing backward and outward.

were operated upon in one stage. One case was associated with a pulmonary abscess and moderate sepsis following pneumonia and empyema. In the other case, a comparatively simple bronchiectasis after seventeen years became putrid during the last six months before the operation. Both developed a mild form of empyema but their subsequent convalescence has been uneventful.

**CASE 1.** I. B., age 30 years, married, with four children, entered the hospital April 13, 1933 with a right lower lobar type 4 pneumonia. Her temperature gradually returned to normal on the fourteenth day. On April 29, the seventeenth day of illness, 300 c.c. of thin turbid fluid was withdrawn from the right pleural cavity. Culture showed *Streptococcus hemolyticus*. On May 6, thick yellow pus was evacuated through an intercostal incision. Flapper tube drainage was maintained until there was no discharge from the wound. On

May 24, expectoration became foul and a diagnosis of lung abscess was entertained. Postural drainage outdoors resulted in a general improvement.

The patient was discharged on June 28 with radiographic evidence of complete expansion of the right lower lobe. There was no cough or expectoration and the wound was healed.

She was readmitted on September 15, 1933 with a nonproductive cough and evidence of reaccumulation of pus in the pleural cavity. On September 19  $1\frac{1}{2}$  inches of the seventh rib were resected. The culture of the pus evacuated from the pleural cavity again showed *Streptococcus hemolyticus*. She was discharged to the out-patient clinic on October 27, when there was no further drainage from her incision.

She was readmitted for the third time on December 21, with a history of fever, chills, productive foul expectoration with intermittent drainage from the empyema sinus. A flapper tube was reinserted through the old incision and considerable pus was evacuated. Trendelenburg postural drainage was again resumed effectively. Within a few days the temperature was normal, the expectoration and discharge from the wound became scant. On January 10, 1934, bronchoscopic examination with lipiodol (Fig. 1) by Dr. Robert Moorhead showed a compressed right bronchus and a large wing-shaped shadow extending obliquely forward and outward and the other wing backward and outward. These bronchiectatic cavities did not have radiographic evidence of external communication.

On January 12, nine months after the onset of pneumonia, the right lower and middle lobes were removed in one stage under avertin and nitrous oxide and oxygen anesthesia. The pleural cavity was exposed by resecting the fifth and sixth ribs. A Lilienthal rib spreader was used. The right lower lobe was found to be firmly adherent to the chest wall and diaphragm. The pedicle was ligated with three silk braided sutures. After carbolization of the bronchial stump, the bronchus and branches of the pulmonary artery and vein were then ligated separately with chromic sutures. Two rubber tube drains and the silk pedicle suture were brought out through a small wound in the sixth interspace. The patient was transfused with 400 c.c. of blood at the completion of the operation.

The tubes were removed on the fourth day and a flapper tube was reinserted. Drainage

was purulent and profuse for several days. The patient, in good general condition, was discharged to the out-patient department on February 5, 1934, with a discharging sinus.

and some pus were evacuated. She was discharged from the hospital on July 28, 1934, with the wound healed. It has remained healed ever since.



FIG. 2. Case 1. Weigert's elastic stain of bronchus. The wall of the bronchus shows disruption of the elastic membrane and mononuclear cell infiltration.

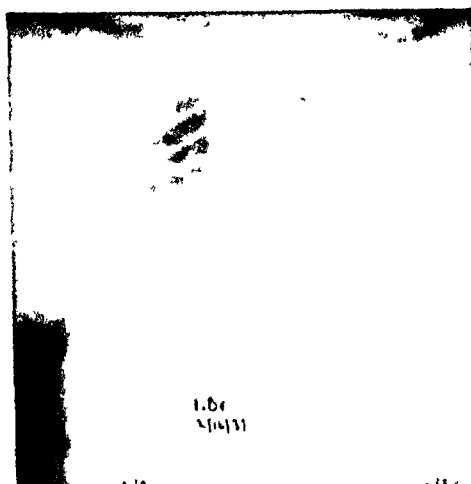


FIG. 3. Case 1. February 16, 1937, lipiodol study, revealing contrast media evenly distributed in the right upper lobe. The upper lobe had expanded to the lateral chest wall and to the elevated dome of the diaphragm.



FIG. 4. Case 1. May 16, 1930. Partial narrowing of the right thoracic cavity and marked thickening of the pleura in the right lower half. The thoracic cavity is occupied by the expanded right upper lobe in the upper half of the chest. There is no displacement of the mediastinum.

The pathologic report showed a chronic pneumonitis with fibrosis of the lung and cylindrical bronchiectasis and chronic adhesive pleuritis. (Fig. 2.)

On June 19, 1934, the patient was again admitted, with the sinus discharging. This wound was enlarged. The three silk ligatures, which were found loose in the pleural cavity,

In February, 1937, lipiodol studies revealed the contrast media evenly distributed in the right upper lobe. The upper lobe has expanded to the lateral chest wall and to the elevated dome of the diaphragm. (Fig. 3.)

The patient has since given birth to another child, labor being smooth and without any embarrassment of the cardiorespiratory system.

Radiographic examination on May 16, 1939, revealed partial narrowing of the right thoracic cavity and marked thickening of the pleura



FIG. 5. Case 1. Five years after removal of the right lower and middle lobes.

in the right lower half. The thoracic cavity was occupied by the expanded right upper lobe in the upper half of the chest. There was

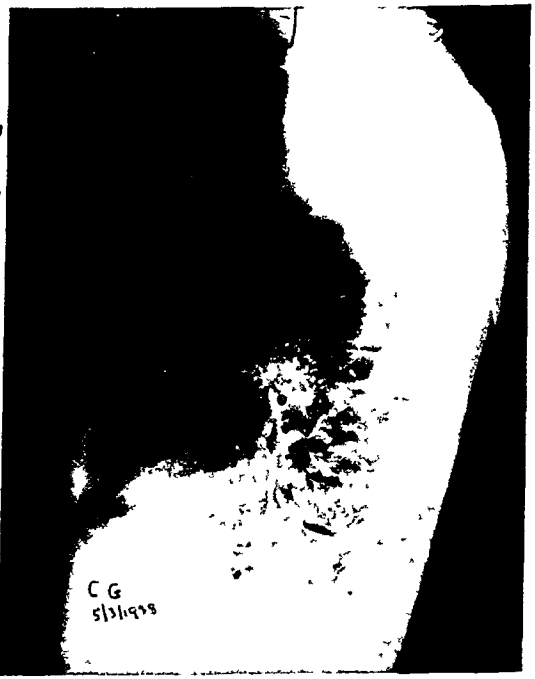


FIG. 6. Case 11. Lipiodol studies by bronchoscopic instillation. Numerous saccular and fusiform bronchiectatic cavities involve the entire lower left lobe to the periphery of the lung.

no displacement of the mediastinum. (Fig. 4.) In June, 1939, five years after operation, the patient was able to climb stairs and scrub

floors without respiratory embarrassment. (Fig. 5.)

CASE 11. A woman, 25 years of age, married, with two children, for seventeen years had had a troublesome cough with profuse expectoration. For the previous five months the sputum had become foul and offensive. The only previous history of illness that could be elicited was a persistent "bronchitis" during childhood which was activated by frequent "colds and laryngitis." Every morning for seventeen years she awakened with a harrassing cough and produced large amounts of yellowish "phlegm." Occasionally she had pains in the left side of her chest. These symptoms became aggravated during the last year and for the five months before admission the expectoration became so profuse (6 to 10 ounces) and offensive that she sought admission to a hospital.

Ours was the third institution in which bronchoscopic and lipiodol studies revealed numerous saccular and fusiform bronchiectatic cavities involving the entire lower left lobe to the periphery of the lung. (Fig. 6.) The left

upper lobe and the right lung upon fluoroscopic and lipiodol x-ray examination showed no pathology.

The patient weighed 130 pounds; her breath was foul; and there was a diffuse enlargement of her thyroid. There was marked clubbing

pleural cavity revealed only a few adhesions binding the lung to the diaphragm. A mass ligature of braided silk was used to ligate the

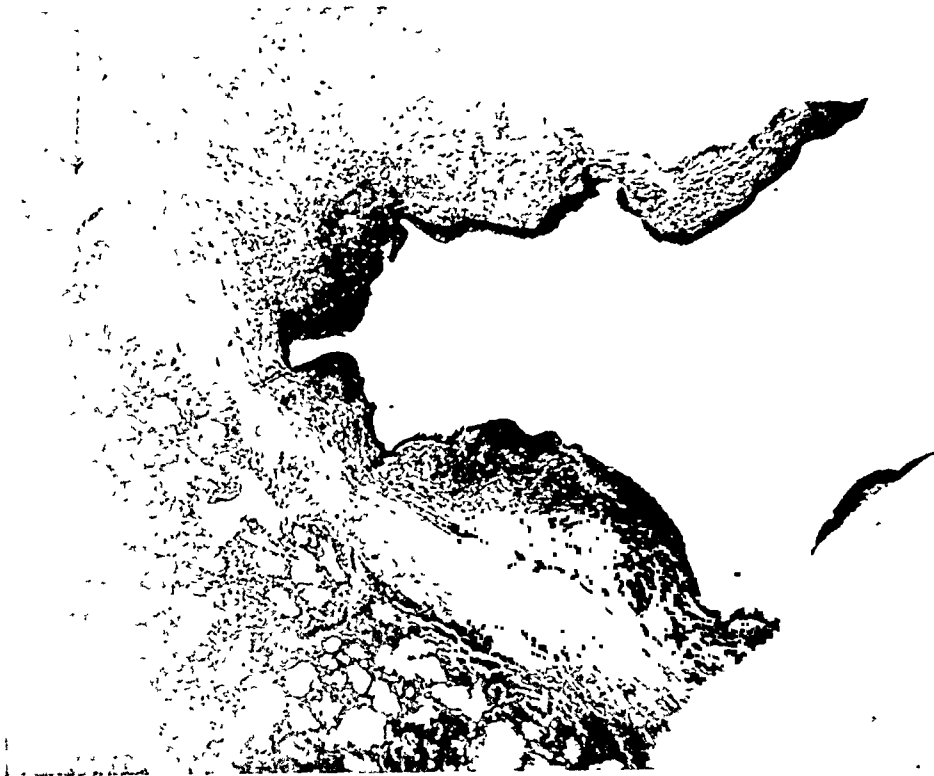


FIG. 7. Case 11. Squamous epithelial metaplasia of the bronchial epithelium with diffuse mononuclear cell infiltration and scarring.

of the fingers and slight clubbing of the toes. She tired readily on the slightest exertion. Over the left base there were diminished resonance, roughened bronchovesicular breath sounds with sibilant and sonorous râles. Repeated sputum examinations for tubercle bacilli were negative as were other cytologic examinations. Hematologic examinations were essentially negative.

Supportive treatment included a transfusion, postural and bronchoscopic drainage, and sleeping in the Trendelenburg position.

At operation on May 10, 1938, seventeen years after the onset of symptoms and six months after the sputum became offensive, the lower lobe of the left lung was removed in one stage under cyclopropane anesthesia. A posterior oblique incision was made, beginning from the second rib close to the spine, extending to the eighth rib, and curving to the posterior axillary line. The fourth rib was resected and  $\frac{1}{4}$  inch of the third, fifth, sixth, seventh, and eighth ribs was removed about 1 inch from the articulations with the spine. Opening the

pedicle. The stump of the bronchus was carbolized and the branches of the pulmonary arteries and veins were separately ligated with chromic catgut. A flapper drainage tube was inserted into the eighth interspace. The patient received 500 c.c. of blood during the operation. Positive pressure was maintained during the closure of the chest and during the time the patient was being transported to her bed and placed under the oxygen tent.

There was no postoperative reaction of any consequence. The value of the oxygen tent was appreciated when the oxygen was temporarily discontinued to permit dressing of the wound. The patient became cyanotic and dyspneic. After several days the tent and drainage tube were gradually discontinued. The expectoration became less and in about six weeks it had entirely ceased. The pathologic report showed chronic interstitial pneumonitis, chronic bronchitis and bronchiectasis. (Fig. 7.) Radiographic examination on April 18, 1939 showed the left upper lobe expanded to the chest wall and the parenchyma well illuminated. (Fig. 8.) There



was slight increased contraction of the left hemithorax and slightly increased bone regeneration at the severed ribs.



FIG. 8. Case 11. April 18, 1939. The left upper lobe expanded to the chest wall and the parenchyma well illuminated. There is increased contraction of the left hemithorax and slightly increased bone regeneration at the severed ribs.

After one year the patient could walk three flights of stairs to her apartment without becoming distressed. She did not cough or expectorate and had gained considerable weight. (Fig. 9.)

#### COMMENT

The Trendelenburg position was employed before the operations for postural drainage and to accustom the patient to lie on the side of the unaffected lung in the position to be assumed during the operation and during the immediate postoperative state.

Pneumothorax was not employed in either patient. In the first patient the numerous pleural adhesions resulting from the empyema precluded such a procedure. The advisability of preoperative collapse was considered in the second patient with the object of immobilizing the mediastinum

and permitting the right lung to make compensatory readjustment in breathing and thus reduce the assault to the cardiorespira-

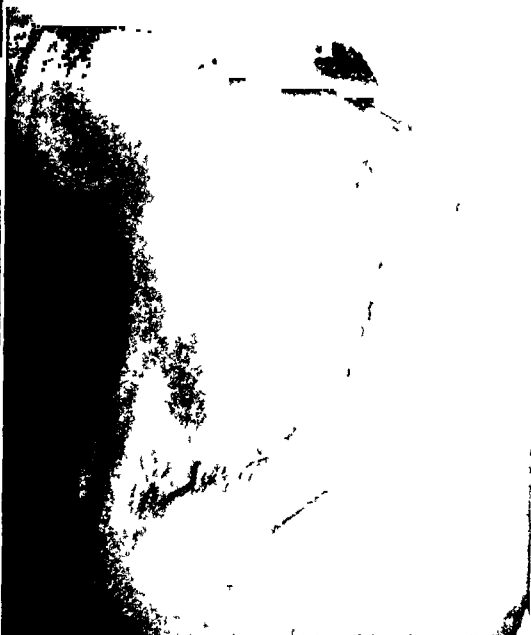


FIG. 9. Case 11. June 12, 1939, one year after removal of the left lower lobe.

tory apparatus. However, pneumothorax was not attempted for two reasons: (1) because with the existence of a profuse foul mucopurulent expectoration there was the possibility of compressing the bronchus and impeding drainage; and (2) because the bronchogram revealed that the disease had extended to the periphery of the lung, which, if injured, might have initiated an empyema.

Kalb<sup>18</sup> claims that pneumothorax is not an innocuous procedure. He has observed that 60 to 80 per cent of tubercular patients develop pleurisy with effusion and 16 per cent develop empyema after pneumothorax.

As anesthesia, avertin, nitrous oxide and oxygen were used in the first case and cyclopropane in the second. Positive pressure was maintained at the completion of both operations until the patients were transported to the ward and placed in oxygen tents.

Cyclopropane is undoubtedly a very desirable anesthetic as only minimal anox-

emia is possible. Intratracheal anesthesia was not employed, since satisfactory control of the expansion of the remaining lobes was efficiently maintained by the pressure in the rebreathing bag with the use of a snugly fitting face mask. Intratracheal suction was not found necessary in either case although the anesthetist was prepared for it should it have been found advisable.

In both cases the approach was through a posterior incision in the sixth interspace, as recommended by Lilienthal. In the first case because of the previous operations for empyema, the fused fifth and sixth ribs were resected. This approach gave easy access to the right lower lobe which was firmly adherent to the chest wall and diaphragm. In the second case the posterior incision began at the second rib 2 inches lateral to the spinous process, extended down to the eighth rib, then curved obliquely outward to the posterior axillary line. The fourth rib was resected and one-quarter of the third, fifth, sixth, seventh, and eighth ribs was removed. This exposure was more than ample and greatly facilitated the operation.

The pedicle of the hilum was ligated in both cases by mass ligature with braided silk. The bronchus and branches of the pulmonary artery and vein were then ligated separately with No. 3 chromic sutures. In the first case the silk ligatures were left long and the ends projected through the drainage wound, but ultimately had to be removed.

In the first case two rubber tube drains were used through a small wound in the sixth interspace because of the amount of previous pleural infection. In the second case a small Lilienthal flapper tube was inserted in the eighth interspace. Both patients developed low grades of empyema, though the extent of the infection in the second case was slight.

Both patients were transfused after the operation and the second patient was placed immediately in an oxygen tent even though her condition was satisfactory at the completion of the operation. The advantages of

the oxygen tent in diminishing anoxemia and increased comfort to the patient following pulmonary operations cannot be overestimated.

#### CONCLUSIONS

Two cases of lobectomy for bronchiectasis are reported. One patient showed evidence of sepsis associated with a lung abscess following pneumonia and empyema. She has been followed for five years and has had a normal pregnancy since her lobectomy. The other had a simple and nonputrid bronchiectasis for seventeen years until six months before admission, when evidence of putrid changes ensued. She has been entirely free of symptoms since the removal of her left lower lobe over one year ago.

The results of surgery for bronchiectasis are conceded to be the best in the simple, nonputrid group. Cognizance of this statement must be taken in order to effect a reduction in mortality with radical surgery for bronchiectasis. It is admittedly difficult for the clinician, because of the reported high mortality of lobectomy for bronchiectasis, to abandon conservative therapy even though he has exhausted every other method of treatment. Nevertheless, he must distinguish between the simple nonputrid, the septic, and the putrid groups, because the risk of surgical intervention is different for each. The relatively low mortality for lobectomy in nonputrid cases of bronchiectasis should be an impetus to the physician to refer this group for surgery before some intercurrent infection activates the disease into the septic or putrid stage. It is gratifying to note that the mortality in each group has appreciably lessened in recent years because of the superior preoperative preparation, better anesthetic agents and their more effective administration, the judicious choice of the one- or two-stage operative procedure and improved postoperative care, all manifestations of the development of better coöperative effort in the management of a precarious undertaking which

offers the only permanent relief from a disabling disease.

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# PERIPHERAL ARTERIAL EMBOLISM\*

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PERIPHERAL arterial embolism occurs with sufficient frequency in the large general hospital to warrant special interest in its diagnosis and treatment. These cases offer a perplexing problem to the surgeon as their condition is often too poor to warrant radical therapeutic measures, and conservative methods too often are unsuccessful. In an attempt to evaluate the result of therapy, the records of twenty-five patients treated at the Cook County Hospital during the years from 1928 to 1938 were reviewed. This by no means represents all the cases, as many have been filed under other diagnoses or have remained unrecognized. It is also probable that there have been spontaneous cures through the establishment of collateral circulation.

## ETIOLOGY

Peripheral arterial embolism strikes with almost equal frequency in males and fe-

TABLE I  
AGES BY DECADES

Age	1-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79
Cases	2	0	4	3	5	3	6	2

males. In our series there were eleven males and fourteen females. Although the patients may be of any age from childhood to old age, most of the cases occur in late adult life. In our series there were two patients under 10 years and two patients between 70 and 80 years. (Table 1.) The largest

number, however, occurred in the sixth decade, and the average age was 42 years. There does not appear to be any racial predisposition to the disease. In our cases seven of twenty-five patients were colored. This approximately parallels the general admission ratio of the hospital.

As is usually observed, mitral heart disease, on the basis of subacute bacterial or chronic rheumatic carditis, is the direct etiologic agent. Nine of our patients had rheumatic heart disease, and five others were diagnosed as either malignant or subacute bacterial endocarditis.

In thirteen of our cases there was active fibrillation at the time of the embolism; five were being digitalized.

Seven of the twenty-five patients had chronic myocarditis with definite arteriosclerotic changes.

In none of this series was diabetes present, nor was there any factor suggesting previous pulmonary infarction, although three patients met death with terminal pulmonary emboli. (Fig. 1.)

The lower extremities are more frequently involved than the upper. Only five of our twenty-five cases were in the upper extremity. Petit-Pierre graphically represented the usual sites of embolism. (Fig. 3.) We have listed the percentages of this series with his classical representation.

## TREATMENT

The treatment of arterial embolism is divided into four types: non-operative; arteriotomic operations; arterectomic; and

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amputative operations. Most of the reports in the literature concern themselves solely with the results of embolectomy.

any hopeful procrastination. This is especially true of a saddle embolus at the aortic bifurcation. One should not wait once the



FIG. 1. The pulmonary embolus of Case XIV.

Conservative therapy aims to (1) release the concomitant vasospasm; (2) improve collateral circulation; (3) relieve pain. Only a small percentage of cases survive conservative measures without going on to amputation. Because many are old and debilitated individuals with poor circulatory efficiency and reserve or with previous vascular occlusions in the extremity, conservative therapy is the only method possible.

An embolism to the upper extremity can usually be treated conservatively because the collateral circulation will furnish sufficient blood to the limb.<sup>10</sup> The patient should be kept in bed with the extremity flat or slightly dependent. General supportive measures should be carried out as indicated. Antispasmodic drugs, such as papaverine hydrochloride, gr.  $\frac{1}{2}$ , given intravenously every four hours, or sodium nitrite gr. 1 every two hours, have proved very helpful.<sup>24</sup> The use of hypertonic salt solution (5 per cent, 200 c.c. intravenously) is valuable.<sup>11</sup> The positive and negative pressure boot and intermittent venous compression have yielded excellent results.<sup>25</sup>

Embolism of any large vessel in the lower extremity down to and including the popliteal arteries is a surgical emergency and should be treated as such at once without



FIG. 2.

FIG. 2A.

FIG. 2. Reformation of the thrombus at the aortic bifurcation following operation (Case XIV).

FIG. 2A. The intimal suture line after removal of the clot (Case XIV).

diagnosis and site of lodgement of the embolus are reasonably certain.<sup>2</sup> Pearse,<sup>23</sup> de Takats,<sup>21</sup> and others have shown the importance of this time factor, ten hours, in the performance of an embolectomy. If this time is exceeded, reformation of a thrombus at the site where the embolus has impinged becomes an added risk to embolectomy. (Fig. 2.) Propagating thrombi in the large veins of the calf muscles may be anticipated.<sup>2</sup> The final cause of death is usually subsequent embolic phenomena in many of these cases.<sup>9</sup>

As to the operation itself, spinal anesthesia is used in preference to general anesthesia because of the maximum vasodilatation obtained.

If it is found impossible to secure a free flow of blood after the embolus is removed, it is best to remove a segment of the artery

prove. Then there is a general increase in the toxemia. The fever rises, the pulse accelerates, and a moderate leucocytosis give

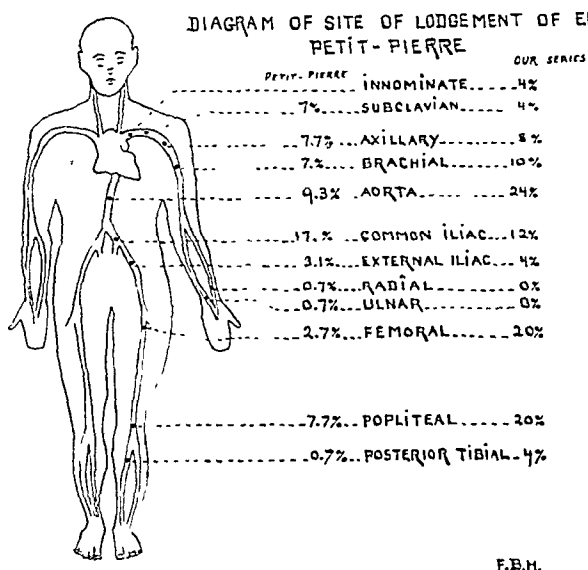


FIG. 3. Diagram of site of lodgement of emboli (Petit-Pierre as compared to our series).

(arterectomy), according to Leriche and Fontaine,<sup>27</sup> thus removing the irritable focus of the vasospastic reflex and facilitating collateral circulation.

#### DISCUSSION

The reader may gather the impression that the above series has done little to add to the general knowledge of the therapy of peripheral embolism except to cast an air of pessimism upon any attempts at therapy. We do not believe this to be true. We have learned one important fact from the review of the clinical histories. This is that the usual case follows a more or less typical course towards a fatal termination, and that we can alter this course. The patient suffers the arterial accident and is brought to the hospital in poor general condition. Conservative methods are employed, as have already been discussed, and the patient then seems to rally and appear to be in a much better condition. Meanwhile the extremity becomes gangrenous and a partial demarcation of the gangrenous area takes place. As the patient improves he is kept on this conservative management for days or even weeks, appearing constantly to im-

evidence of this toxemia. As this increases, the alarm of the attendants becomes acute, and at last the emergency guillotine amputation is performed. This is followed by shock, infection, and death.

In cases in which amputation was done as soon as signs of improvement were apparent, the results were better. These amputations were far better borne and could be carried out as planned, elective procedures.

#### PROGNOSIS

The prognosis of arterial embolism is usually discussed as though success or failure of therapeutic measures depended on whether or not the extremity was saved. Less frequently does one find a discussion of the life outlook of the patient who has suffered the acute arterial accident. Both are, of course, important. In this review the strikingly high general mortality has been significant. We believe that this is due to several factors which are not common to all series of cases. These patients were observed in a large general hospital and the diagnoses were the primary ones. In other words, many other cases of arterial embolism have occurred in the time period cov-

TABLE

No	Name	Age	Sex	Color	Clinical Diagnosis	Duration of Illness	Site of Embolus	Blood Pressure	Clinical Picture
1	C T	36	M	White	Ulcerative colitis, coronary occlusion with mural infarction	10 days Recent	Left axillary artery	120/80	Four days after admission patient suddenly developed severe pain in left arm, loss of warmth and sensation, pallor, and then blueness from elbow down. Symptoms gradually cleared up, five days later soft systolic murmur heard. On tenth day after onset of embolus complete return of temperature, sensation and motion. Pulse, however, not palpable at left wrist.
2	A M	65	F	Negro	Ulcerative endocarditis, auricular fibrillation	15 years	Left axillary artery	126/60	History of weakness and shortness of breath for 15 years with swelling of ankles of 3 years, cough, loss of 30 pounds weight in past 2 or 3 months. Had at one time been in tuberculosis sanitarium, history of six miscarriages. On admission she was found to have shrill musical systolic murmur, bilateral fibroid, tuberculosis, extrasystole and mitral regurgitation. Suddenly developed pain, discoloration of left hand, inability to move left forearm, petechial showers with progressive downhill course.
3	G D	21	F	Negro	Rheumatic endocarditis	15 years	Left subclavian and right internal carotid	140/50	Patient had rheumatism at ages of 8 and 13, and 6 weeks before admission, paralysis of right side, aphonia 4 weeks, pain in right shoulder and elbow for 2 months. Upon admission blowing systolic murmur with absence of pulse in left arm, left arm cold, blue and discolored—dry gangrene.
4	O N	58	M	White	Coronary sclerosis	4 months	Right innominate artery	Right—100/? Left—120/10	Four years before had flu, 4 months before was in bed with cough, expectorated blood. Four days after admission patient developed sudden numbness of right arm with absence of right radial pulse, arm became cold, cyanotic, brachial pulse disappeared, one week later entire right arm was dry and gangrenous.
5	H B	26	M	White	Chronic rheumatic fever with partial cardiac decompensation, auricular fibrillation	12 years 5 days	Right femoral artery, possible riding embolus slipping down one side	120/70	Complaints of weakness, vomiting, lumbar and epigastric pain, with dyspnea, swelling of ankles for 5 days before admission, sudden onset of severe cramps in both legs, right leg became cold, pulseless and in 3 days purple and mottled.
6	M L	62	F	White	Chronic myocarditis with arteriosclerosis, chronic constipation	12 years 6 months	Right femoral artery	144/90	Two days after admission complained of numbness, tingling and inability to move right leg, no pulsations felt above Poupert's ligament, foot became black.
7	E L	65	M	White	Rheumatic myocarditis, slow auricular fibrillation	14 years 6 months	Right femoral artery just below profunda	178/110	Sudden severe pain in right heel, developing coldness and blueness of foot with loss of sensation, sharp, stabbing, shooting pains extending above knee, cyanosis and coldness of lower leg, absent pulses.
8	A D	79	F	White	Chronic myocarditis with auricular fibrillation	10 years 6 months	Right femoral artery below profundus	250/114	Patient out walking 5 days before admission when she was suddenly seized by sharp, crampy pain in right knee which traveled down leg into foot. On admission right leg appeared cyanotic and cold below knee, no palpable popliteal, dorsalis pedis or posterior tibial pulses on right side.
9	J G	49	M	White	Chronic rheumatic endocarditis	Several years	Left femoral artery		Three weeks before admission patient, while walking, developed severe cramp-like pain in back of left leg by night leg was discolored. This cleared up, 4 days before sudden and severe in left lower leg, purplish discoloration and mottling from middle of leg to ankle with loss of tactile and position sense, hyperesthesia to middle of leg posteriorly, no palpable dorsalis pedis or posterior tibial. Left foot cold. Temperature 103.2, blowing systolic murmur. Gangrene with blue toes and heel of left leg 8 days after onset.

I

Operation	Time between Occurrence of Embolus and Operation	Postembolic Complications	Outcome	Essential Pathologic Findings (If Available)	Miscellaneous
....	.....	Very mild atrophy of muscles of forearm.	Return of function.		
		Coma and glomerulonephritis.	Died 15 days after admission, 10 days after embolic phenomenon.	Embolie occlusion of left axillary artery with dry gangrene of left forearm; thrombo-ulcerative endocarditis of mitral valve; myocardial degeneration; acute hemorrhagic glomerulonephritis.	
			Died 3 days after admission; 4 weeks after onset.	Malignant vegetative endocarditis of mitral valve with mural embolic occlusion of left subclavian and right internal carotid artery.	
		Multiple lung infarcts.	Died 10 days after embolism, 2 weeks after admission.	Clot in the innominate covering right subclavian artery; pulmonary infarction; coronary sclerosis.	
Amputation of right leg above knee	24 days	Possible bacterial endocarditis, although blood culture was negative	Fair.	Popliteal artery in amputated leg contained firm clot.	Had digitalis on admission.
Embolectomy	5 hours	Probable pulmonary embolus.	Death 10 hours later.	No post-mortem examination.	Pulse not palpable after embolectomy.
Amputation of right leg, middle thigh	12 days	Possible cerebral shower of emboli (irrational).	Good.	.....	Had digitalis on admission.
			Died 2 days after admission, 7 days after onset.		
Midthigh amputation	13 days	Purulent infection of stump; peritonitis; uremia	Died 24 days after onset, 9 days after amputation.	Arterio-sclerotic gangrene with thrombosis of posterior tibial artery.	May be question whether this is a thrombosis.



TABLE I

No.	Name	Age	Sex	Color	Clinical Diagnosis	Duration of Illness	Site of Embolus	Blood Pressure	Clinical Picture
10	P. Y.	55	M.	White	Auricular fibrillation.	6 years	Saddle embolus (aortic bifurcation)	.....	Sudden severe bilateral pain, numbness and cold developing in both legs, with purplish discoloration of both feet; right leg popliteal circulation returned; pulses absent in feet.
11	M. L.	62	F.	Negro	Decompensation with chronic myocarditis.	1 year	Saddle embolism of aorta	140/100	Patient entered hospital shortly after onset of sudden numbness without pain, paralysis, tingling of both legs, duration 1 hour. Physical examination: no murmurs; pulse irregular, pallor, coldness of both legs and thighs; went on to mottled discoloration with absence of sensation, paralysis, loss of tendon reflexes; no dorsalis pedis or popliteal pulse in either leg; patient stuporous.
12	A. R.	26	F.	Negro	Malignant endocarditis; self-induced abortion.	2½ weeks 3 weeks	Saddle embolus; (aortic bifurcation)	.....	History of numerous self-induced abortions; three weeks before entrance had performed another abortion, followed in 3 days by general muscular aches and pains and temperature. Three days before admission developed a delirium; at admission both legs markedly edematous and cold with beginning discoloration.
13	L. B.	38	F.	White	Auricular fibrillation with rheumatic myocarditis.	6 months	Saddle embolus (aortic bifurcation)	.....	Six months before, patient had a stroke with right sided hemiplegia. Thrill, systolic, diastolic murmur; auricular fibrillation on admission. Lower third of left leg discolored and colder than right; popliteal, femoral and dorsalis pedis pulses not palpable in either leg. Embolectomy considered but general condition poor; gangrene and discoloration were progressive.
14	W. C.	52	M.	White	Chronic myocarditis; auricular fibrillation (old heart disease). Saddle embolus at aortic bifurcation.	30 years 3 hours	Saddle embolus (aortic bifurcation)	.....	Good health but for a longstanding heart disease; fairly well compensated; awoke suddenly one morning and found himself unable to use either lower leg; legs became cold and blue. Entered hospital 3 hours later; both limbs blue, cadaveric and cold; no pulsations of femoral or external iliac felt.
15	A. S.	47	F.	White	Chronic myocarditis with auricular fibrillation.	2 years	At aortic bifurcation and into left common iliac	160/118	Sudden severe crampy pain in both legs while lying in bed. On admission, right leg cold and blue to mid thigh with no dorsalis pedis, posterior tibial or popliteal pulse and no oscillometric fluctuations in either leg. Entire left leg cold and blue to hip. Transperitoneal approach to aortic bifurcation.
16	E. A.	9	M.	Negro	Subacute bacterial endocarditis.	5 months	Right common and left common iliac	.....	Had rheumatism 5 months before admission; 5 days before admission had cough, fever, headache, aphonia, repeated vomiting attacks developed blueness, edema, coldness of both lower legs. On admission temperature 101, blowing systolic murmur, friction rub, petechial crops and marked cardiac enlargement.
17	J. B.	40	M.	Negro	Malignant endocarditis.	10 years	Right common iliac artery	130/50	Had rheumatism 10 years before; for the past 3 weeks chills, fever, dyspnea, palpitation, heart consciousness, cough, nocturia. On admission double murmur at apex, rough aortic second with Durozieg's sign and Corrigan and capillary pulse. Negative Kahn; blood culture repeatedly positive for <i>S. bemchlyticus</i> . Progressive downhill course. Right leg suddenly became cold and numb and went on to dry gangrene.
18	L. R.	24	F.	White	Malignant endocarditis.	3 weeks	Right external iliac artery	92/9	Developed a cold 3 weeks before; backache, fever and chills for 10 days; loud apical systolic murmur. Blood culture positive for <i>S. viridans</i> . Sudden onset of pain and coldness of right leg. Pulses gone in a cold blue extremity.

(Continued)

Operation	Time between Occurrence of Embolus and Operation	Postembolic Complications	Outcome	Essential Pathologic Findings (If Available)	Miscellaneous
Amputation of left leg	14 days	Pulsus deficit.	Died 28 days after amputation; cardiac death.	No post-mortem examination.	
.....	.....	Coma	Died 48 hours after onset.	Embolism of both femoral arteries.	
.....	.....	Hemorrhagic encephalitis.	Died 3 weeks after abortion, 3 hours after admission.	Acute hemorrhagic leucocytic encephalitis; parenchymatous degeneration of myocardium; gray firm mass which straddled bifurcation of aorta.	
.....	.....	.....	Died 8 days after onset.	Embolie occlusion of lower aorta with secondary thrombosis of iliac and femoral arteries; mitral deformity and stenosis; mural thrombus in left ventricle and dry gangrene, both legs.	
Transabdominal approach with aortic embolectomy	6 hours	Pulmonary embolism.	Died 48 hours after onset, 42 hours after surgery.	Embolie occlusion of right main pulmonary artery; thrombosis of abdominal aorta; fibroplastic mitral deformity; cardiac dilatation; beginning gangrene of both legs.	Had digitalis on admission.
Embolectomy pulse returned in left leg	6 hours	.....	Died 36 hours after operation.		
.....	.....	Bronchopneumonia and acute glomerulonephritis.	Died 11 days after admission, 6 weeks from onset of last attack.	Thrombo-endocarditis of mitral valve; multiple abscesses of myocardium; anemic infarcts and abscesses of spleen and kidneys; acute glomerulonephritis and bronchopneumonia; embolic aneurysm of right common iliac; embolic thrombotic occlusion of common iliac.	
.....	.....	Septicemia.	Died 3 days after admission, 3 weeks after onset of acute exacerbation, 14 days after onset of embolus.	Malignant endocarditis of mitral and aortic valves with old fibroplastic deformity; fibrinous pericarditis; mycotic emboli to kidneys; embolus to right iliac artery with dry gangrene of right leg.	
.....	.....	Septicemia.	Died 18 hours after admission, 10 days after onset of embolus.	Acute malignant endocarditis of mitral with focal interstitial myocarditis; external iliac occluded just beyond opening, hypogastric artery.	

TABLE I

No.	Name	Age	Sex	Color	Clinical Diagnosis	Duration of Illness	Site of Embolus	Blood Pressure	Clinical Picture
19	J. M.	74	F.	White	Chronic myocarditis with auricular fibrillation.	Several years	Right common iliac artery	100/70	Patient had rheumatism for a number of years; on day of admission she experienced sudden pain in right leg and inability to move this leg. Leg progressed to extensive dry gangrenous changes; heart rate rapid with poor tones.
20	M. S.	63	F.	White	Chronic myocarditis with large heart and mitral regurgitation.	12 years	Left popliteal artery	.....	Five days before admission experienced sudden cramping pain in the left lower leg. Leg went on to coldness, numbness. Left femoral palpable but left popliteal absent as was left dorsalis pedis. Poor condition prevented amputation.
21	P. N.	63	M.	Negro	Arteriosclerosis with chronic myocarditis.	4 years	Left popliteal artery	.....	Four years before admission had a similar acute attack of pain in right leg which resulted in amputation. Two days after onset of an intermittent sticking pain in left leg, suddenly developed severe continued pain in this leg and entered hospital. No palpable left popliteal or dorsalis pedis; 8 days after onset toes were gangrenous, ankle and foot discolored, and demarcation was being established. (Sixteen days after-onset blood pressure suddenly dropped to 72/52.)
22	M. U.	38	F.	White	Rheumatic heart disease with fibrillation.	Chronic	Popliteal bifurcation in left leg	.....	Admitted with 2 hour history of pain, cramp-like and excruciating, up to middle third of thigh. Patient had been bedridden for some time. On admission temperature 96. Tachycardia and fibrillation, loss of function of foot, coldness to popliteal space and discoloration of foot. Both femoral pulsations poor; faint posterior tibial pulsation in the good leg, no demarcation.
23	M. L.	4	F.	White	Rheumatic endocarditis with auricular fibrillation.	7 weeks	Bilateral popliteal arteries	150/100	Patient developed cold 7 weeks prior to admission; 4 weeks before sudden severe pain in left leg below knee. Knee began to swell, blisters and blackened areas of discoloration appeared on leg and foot. Both legs then became cold, swollen and tender and left foot necrotic. On admission she was markedly dyspneic on exertion with no palpable dorsalis pedis of left foot.
24	J. M.	44	M.	White	Old rheumatic heart disease and auricular fibrillation.	8 years	Bilateral popliteal arteries	130/82	Shortness of breath for 8 years; entered hospital with irregular pulse fibrillating; put on digitalis; 18 days after admission left leg became suddenly cold and blue; on the twentieth day both legs became blue and by the twenty-third day they were covered with blebs.
25	C. L.	48	F.	White	Auricular fibrillation.	3 months	Right leg posterior tibial artery	130/70	Sudden onset of pain in right leg to knee and toes with tenderness in right popliteal space; loss of pulsation, heat, color, function and sensation in right foot; developed a gangrene of right foot; toes sloughed four months after onset.

ered, but the records have been filed under other headings. Thus, many of these records were located by searching necropsy reports. In others the embolism was the terminal factor and, therefore, received special attention. It is for this reason that the general mortality percentage is unusually high.

The mortality of the disease is, however, very high for several reasons. Arterial embolism is usually but one of the complications or sequelae of some other systemic disease, which of itself bears a high mortality rate. If a person has an arterial embolism to the femoral artery, he may very well have others to the brain or other vital

(Continued)

Operation	Time between Occurrence of Embolus and Operation	Postembolic Complications	Outcome	Essential Pathologic Findings (If Available)	Miscellaneous
		Pulmonary embolism	Died 9 days after onset	Mural thrombi in auricles, hypertrophied heart, degeneration of occlusion-right monary embolus	
			Died 16 days after onset, cardiac death		Had digitalis on admission
Amputation of left leg just above knee	20 days		Died 20 days after onset and 6 hours after amputation	Arteriosclerotic aneurysm of popliteal with embolus to popliteal artery	
		Spreading cellulitis and gangrene	Died 59 days after onset, cardiac plus sepsis		
Bilateral amputation, mid-calf	4 weeks	Embolic occlusion of superior mesenteric artery	Died 5 months after admission, 6 months after onset	Fibroplastic deformity of mitral valve with ball-valve thrombus in left auricle, occlusion of superior mesenteric artery and gangrene of upper jejunum, embolic occlusion of both popliteal arteries	
		Sepsis	Died 42 days after onset		Digitalis
		None	Home, loss of toes of right foot		Had digitalis on admission

center. As most of these occurred in patients of advanced years, one must consider all of the dangers which beset senility, hypostasis, myocardial disease, etc. Others occurred in patients with severely damaged hearts who were unable to bear the brunt of a gangrenous toxemia.

The prognosis for the saving of the limb is equally poor. There were too few cases in this series to pass judgment on the results of embolectomy. Other authors have, however, demonstrated its value in the early hours of the catastrophe.<sup>14 15</sup> In this series, the conservative measures have not been

very efficacious. This may be accounted for by the poor general status of the patients, and the fact that almost all of them had emboli in the larger vessels. As has been said, it is probable that a more

must, however, be done in a large percentage of the cases.

There is a "time of election" for the amputation, viz., when the patient's general status has been improved, and before the toxemia has developed. An amputation which does not open up new fascial spaces is one of choice.

TABLE II  
ETIOLOGIC OR CONCURRENT DISEASES

Disease	Cases
Ulcerative colitis.....	1
Coronary occlusion.....	2
Rheumatic heart disease ..	9
Arteriosclerosis.....	7
Chronic myocarditis.....	7
Ulcerative and malignant endocarditis.....	5

complete picture of the value of conservative measures might be gleaned from a more complete series. (Table III.)

We again repeat our preference for the Callendar tenoplastic amputation, or disarticulation of the knee joint, as few fascial

TABLE III  
RESULTS

Treatment	Average Life Duration from Onset	Cases	Case Mortality	Percentage Mortality
Embolectomy.....	39 hours	3	3	100
Amputation.....	47 days	6	4	66
Conservative.....	20 days	16	14	88

spaces are then opened. Subdural infiltration as previously stated is our method of choice for anesthesia.

#### CONCLUSIONS

Acute arterial embolism of the extremities is a complication of other disease. It therefore adds the mortality of the embolism to the mortality of the preëxisting lesion. Embolectomy should be carried out in favorable cases, within six hours of the onset. Conservative measures may be of benefit and may save the extremity as there is a diffuse vasospasm accompanying the lodgement of the embolus. Amputation

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PATHOLOGIC conditions of the arteries will be recognized by the uneven or moth-eaten appearance of the vessel walls. Their course may be wavy and irregular; they may end abruptly.

From—"Peripheral Vascular Diseases" by Kramer (Blakiston).

# A CLOSED CITRATE METHOD OF COLLECTING BLOOD\*

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MEMPHIS, TENNESSEE

A PRACTICAL and relatively inexpensive method of collecting blood for citrate transfusion has been de-

GLASS ADAPTER

AMBER TUBING  
(DAVOL) 18" LONG  
1/4" X 3/32"

AIR OUTLET

WIRE COIL

RUBBER  
STOPPER

570 cc. MARK  
(ADHESIVE)

ERLENMEYER  
FLASK-1000 cc

70 cc. 2.5% NACITRATE  
FIG. 1. The taking set.

veloped at the "blood bank" of the John Gaston Hospital. This method has proved satisfactory in the hands of different members of the house staff who have used it for the collection of more than 2,500 flasks of blood. A description of the equipment and technique is warranted because modifications not in common use are included and because unnecessary surgical preparatory procedures and mechanical suction devices have been eliminated.

*Equipment.* (Figs. 1 and 2.) The taking set consists of the following parts:

1. Erlenmeyer flask, 1,000 c.c. of resistance glass or of pyrex, with adhesive mark at 570 c.c. point.

2. Two-hole rubber stopper, No. 9.

3. Inlet tube, glass, bore  $\frac{3}{16}$  inch, length 6 inches.

4. Rubber tubing, transparent, Davol, bore  $\frac{1}{4}$  inch, wall  $\frac{3}{32}$  inch, length 18 inches.

5. Spring wire coil, made by bending 3 feet of No. 18 brass wire around a stick.

6. Needle adapter, all glass, or glass with luer-lock attachment.

7. Outlet tube, glass with absorbent cotton filter.

8. Cloth bag with two dry test tubes containing cork stoppers.

9. Sodium citrate, reagent grade (Merck), 70 c.c. of 2.5 per cent in freshly distilled water. The citrate is made up just before the taking set is assembled.

In assembling the set the citrate solution is measured in a small graduate and poured into the flask, the rubber stopper with its connections is placed in the mouth of the flask and the cotton bag with its test tubes is tied around the neck of the flask. A small square of gauze is placed around the glass adapter and held in place by a rubber band. The entire set is wrapped in a 24 X 24 inch piece of doubled unbleached domestic. The edges of the wrapper are fastened together with straight pins. The set is autoclaved for fifteen minutes at 15 pounds of pressure. Care is taken to sterilize the sets soon after they are assembled, so that the growth of organisms in the citrate solution and in the tubing is minimized.

The other parts of the equipment are sterilized in enamel surgical jars with lids. These are as follows:

1. Needles, straight stainless steel, gauge 16 to 17, length  $1\frac{1}{2}$  inches. The needles are placed in test tubes with constricted sides and stoppered with cotton plugs. (Fig. 2.)

\* From the Division of Medicine and Clinical Laboratories, University of Tennessee and John Gaston Hospital, Memphis, Tennessee.

The constrictions in the tubes catch the hub of the needle and thus protect the point. These tubes can be purchased from

forceps, the assistant then removes from their respective surgical jars a medicine glass, a cork stopper and a constricted test

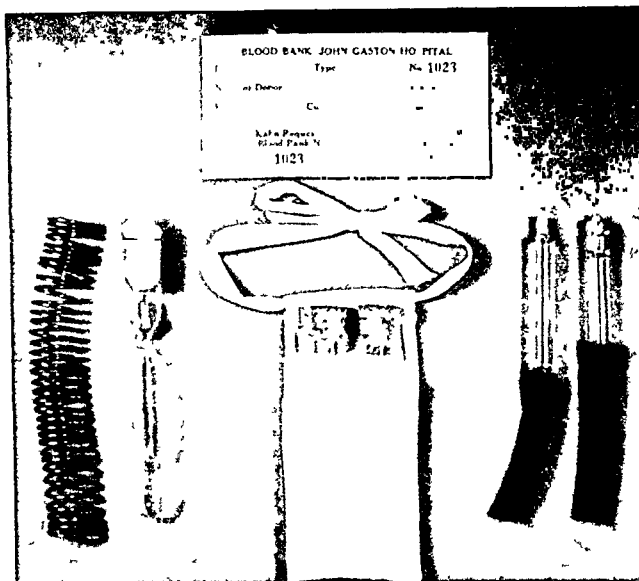


FIG. 2. Label with serial number for flask and with corresponding numbers for test tubes, spring wire coil, constricted test tube with needle, cotton bag with test tubes, adapters.

surgical supply houses, but they can be easily made by heating ordinary glass tubes over a gas flame and bending the sides in with a large hemostat.

2. Medicine glasses (for novocaine).

3. Cork stoppers. These are first covered with several layers of gauze, the corners of the gauze square being tied over the top of the cork. The covered cork is then wrapped in a paper and the paper held in place by a rubber band.

Novocaine, 1 per cent, is made up in sterile flasks. The hypodermic needle and syringes used in administering the novocaine are sterilized in an electric sterilizer.

*Technique.* The donor is placed on the examining table (Fig. 3), the sleeves rolled up and the arms inspected to determine the location of the best veins. The arm selected is placed in a dependent position on the sloping arm board. A blood pressure cuff is applied well above the bend of the elbow. The operator, using a sponge forceps, cleans the antecubital space with an iodine sponge and follows with an alcohol sponge. The assistant opens the taking set. Using sterile

tube containing a needle. These are placed on the inside cover of the taking set, thus avoiding the use of an extra sterile towel.

The assistant pours a few c.c. of sterile 1 per cent novocaine into the medicine glass, fills a sterile syringe, attaches the hypodermic needle and hands the syringe to the operator. The operator infiltrates the skin at the site of puncture. The assistant then takes off the cotton wrapper from the needle adapter and attaches the needle by pushing the adapter firmly down into the hub of the needle. The assistant then hands the adapter to the operator.

The operator inflates the blood pressure cuff to 60 to 80 mm. Hg. He fixes the skin below the site of puncture with one hand and performs the venipuncture with the other. (The hand should at no time touch the needle or the skin near the puncture site. Rubber gloves and sterile drapes are not used and not needed.) The assistant, seated on a low stool, holds the flask near the floor, so that the lower-most portion of the tube is several feet below the level of the donor's heart and the



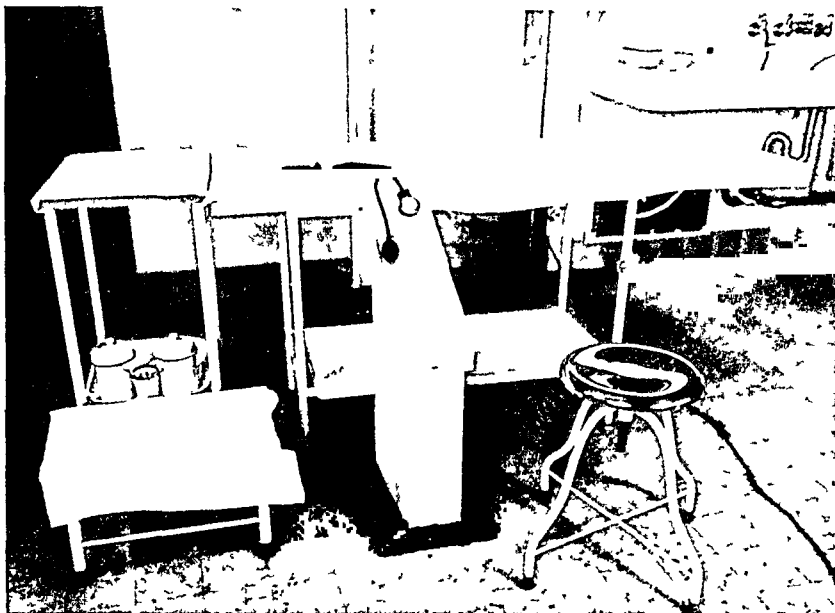


FIG. 3. Taking table with sloping arm board.



FIG. 4. Collection of blood from donor.

flow of blood is straight downward. (Fig. 4.) (The use of gravity suction in this manner makes mouth and mechanical suc-

is held within the paper by grasping the knotted piece of gauze at the top of the stopper. The rubber stopper with its con-

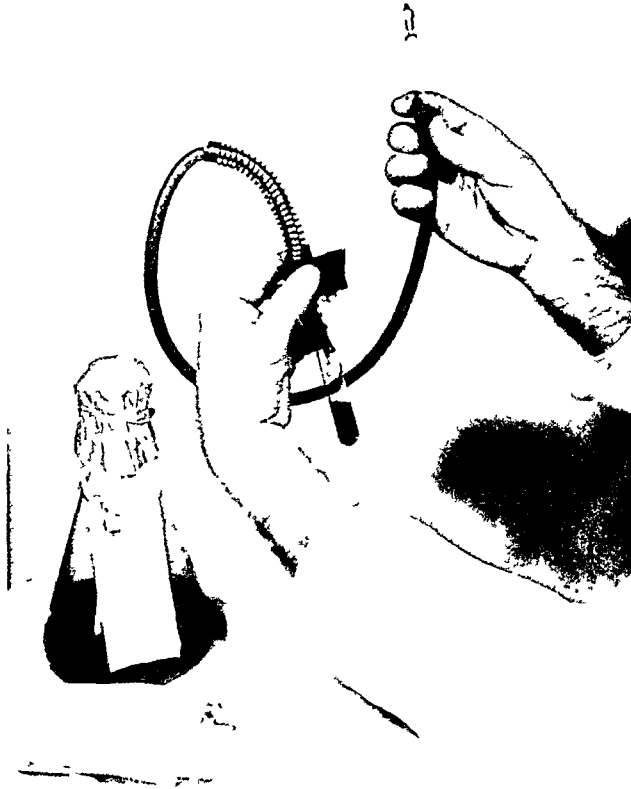


FIG. 5. Collection of blood for serologic test and for typing and cross matching.

tion devices unnecessary.) As the blood flows in, the assistant gently and continually rotates the flask to insure thorough mixture of the blood and citrate. It generally takes five to fifteen minutes to collect the blood. When the blood level reaches the 570 c.c. mark, the blood pressure cuff is released, the tubing is clamped above the spring wire with a hemostat and the needle withdrawn. The assistant takes the flask of citrated blood with its attached tubing while the operator applies pressure over the bleeding point with a gauze sponge and looks after the donor.

The assistant loosens the rubber stopper in the flask. The sterile cork is then unwrapped, care being taken not to touch the cork or the inside of the wrapper. The cork

nections is now removed and the cork stopper substituted. The wrapping paper is bound around the neck of the flask with a rubber band.

The assistant takes one of the sterile tubes from the cotton bags and holds it beneath the glass inlet tube. The hemostat is loosened, and the blood in the tube is allowed to run into the test tube, the flow being controlled by raising and lowering the end of the tube or by compressing the tube. (Fig. 5.) The second tube is filled in the same manner. The clotted blood in one of the tubes is used for serologic tests and the blood in the other tube used for typing and cross matching. The flask is labelled with a gummed label bearing a serial number. Each test tube is labelled with a corre-

sponding number, thus minimizing the writing to be done and aiding in the identification of specimens. (Fig. 2.)

The flask with its test tubes is immediately placed in the refrigerator where it is stored at 4°C. until needed.

#### SUMMARY

A closed method for the collection of blood in citrate solution is described which has the following features:

1. The citrate solution is autoclaved in the taking flask.

2. Rubber gloves, sterile towels, towel clips, special needles, masks, and gowns are eliminated.

3. The blood is allowed to run downhill. Mechanical suction devices are eliminated.

4. A wire coil is used to protect the rubber tubing and to prevent kinking and occlusion of the lumen.

5. Needles are sterilized in test tubes with constricted sides.

6. The blood left in the tubing at the completion of the procedure is collected and utilized for serologic tests and for typing and cross matching.



VENOUS thromboses may be associated with, if not actually a reflex cause of, arterial spasm serious enough in some cases to induce gangrene of the limb.

From—"Circulatory Diseases of the Extremities" by Homans (Macmillan).

# GLYCERIN OSMOTIC DRAINAGE

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THIS is a preliminary paper presenting the principles, and a few applications, of glycerin osmotherapy. A more complete statistical report, with particular reference to the use of the agent in abdominal surgery, is contemplated.

In the early days of physiologic surgery, Murphy<sup>1</sup> placed the limit of an abdominal drain's effectiveness at eighteen hours. Operators attempting to remove drains in accord with this dictum encountered disaster with such disconcerting frequency that even the dullest realized that drains must perform some unaccounted for function beyond the first postoperative day. It became apparent that drains do more than provide a conduit for inflammatory products, and prevent agglutination of the wound edges.

## THE NATURE OF DRAINAGE

J. Shelton Horsley<sup>2</sup> clarified the biologic rôle of drains by showing that drainage material acts as an irritating foreign substance to induce a flow from the lymphatics in its vicinity. He pointed out that if the drainage material is a sufficient stimulus for the reversal of lymphatic circulation, so much lymph pours out that a practically continuous irrigation goes on along the tract of the drain, and that it is relatively unimportant whether the drain tract be up or down. Surgeons are daily witnesses, if not always comprehending ones, to this action of drainage material.

Reversal of lymphatic flow being the essential physiological element of drainage, any substance which evokes a flow of lymph is a drainage agent, whether it functions by irritation, as do mechanical drains, or by osmotic pressure, as do hypertonic solutions. A glycerin pack, used in conjunction with a mechanical drain, will markedly increase the amount of wound discharge over that induced by the mechanical drain alone.

Any factor which contributes to the effectiveness of drainage makes recovery of the patient more probable and more rapid.

The polyhydric alcohol glycerin,  $C_2H_5(OH)_3$ , approaches the ideal as an accessory drainage agent.

## SOME PROPERTIES OF GLYCERIN

Glycerin's osmotic action, by dehydrating wound tissues, contributes to healing, since edema impedes an adequate supply of phagocytic cells in the inflamed area, and edema by widening the lymph channels and increasing local tension favors dissemination of infection. A glycerin solution of 2.47 per cent is isosmotic with sodium chloride 0.85 per cent concentration, and the dehydrating effectiveness of stronger solutions is proportionate to the osmotic pressure of the glycerin solution compared to that of the tissue fluids. The osmotic principle of glycerin drainage is made clear by recognizing the glycerin-soaked cotton pack as a solute, the body tissue with which it comes in contact as a semipermeable membrane and the edema fluid of the inflamed area as a solvent. To secure the maximum osmotic action of glycerin it should be employed in full U. S. P. strength.

The hygroscopic possibilities of glycerin are shown by the Miner Laboratories in a graph which indicates the concentration of the substance in equilibrium with different relative humidities. The curve of this graph shows that at relative humidities higher than 15.5 per cent glycerin will absorb moisture until the equilibrium concentration is reached, and indicates that at humidities found in wounds the capacity of glycerin to absorb liquid discharges is almost incredible.

The toxicity of glycerin has been investigated by Johnson, Carlson and Johnson,<sup>3</sup>

who observed no adverse effects from its ingestion by human subjects or by laboratory animals. Previous reports of injurious

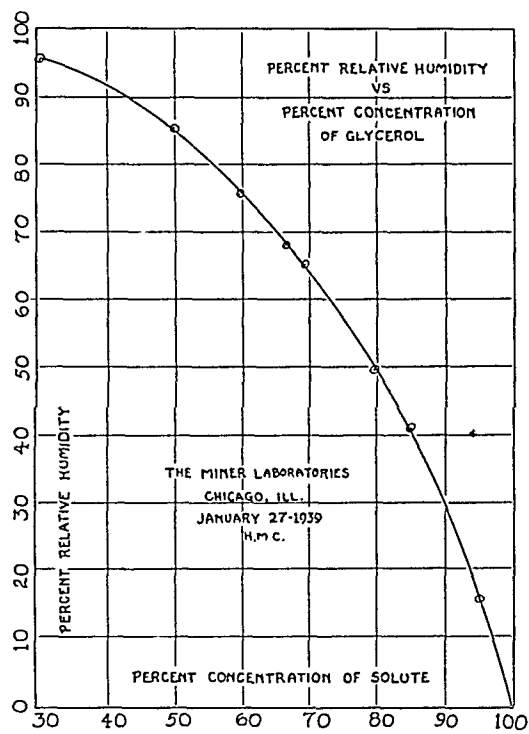


FIG. 1. Graph showing the concentrations of glycerin in equilibrium with air of different relative humidities.

consequences have been based essentially on instances of parenteral administration of glycerin. Rats showed normal growth and normal reproduction after forty weeks of a diet in which carbohydrates were replaced by glycerin to 41 per cent by weight of the total food intake. Fourteen human subjects, on an adequate diet, tended to increase in weight when 110 Gm. of glycerin per day were added over a period of fifty days.

The antiseptic and bactericidal action of glycerin was determined by Ruediger,<sup>4</sup> whose findings were confirmed by Compton.<sup>5</sup> (Table 1.)

Compton also proved that no staphylococci can survive a strength of 26.3 per cent glycerin, but that leucocytes tolerate concentrations up to 41.7 per cent, which fact places glycerin as an antiseptic in what he terms "the bacterial indifferent zone of cytobacterial activity." Glycerin's

unusually favorable ratio of toxicity to bacteria and body cells is obviously of assistance in wound healing. The findings of Compton do not make it illogical to use full strength glycerin dressings for their maximum osmotic effect, since wound discharges promptly dilute the glycerin in immediate contact with the wound and protect the tissues from irritation.

TABLE 1

Organism	Antiseptic Response, Hours	Bactericidal Response, Hours
B. coli comm.....	15	18
B. coli.....	12	15
Staphylococcus.....	12	15
Strep. hemolyticus.....	6	8
Gonococcus.....	1½	1

Many surgeons have unbounded confidence in the bactericidal action of dye-stuffs, and if one cares to combine dyes with glycerin it will be found that mercurochrome 2 per cent, neutral acroflavin or gentian violet 1:1000, malachite green 1:500 and picric acid 1 per cent (by first dissolving the crystals, 1 grain to 1 c.c., in alcohol), and others are readily prepared. These glycerin-dye mixtures, in common with other bactericidal agents, are more effective when used hot since surface tension decreases with increasing temperature. Glycerin-dye mixtures of concentrations in Compton's favorable cytobacterial zone have been utilized in the treatment of a number of infections, Pleth<sup>6</sup> reporting excellent results in empyema, joint infections, and various urologic conditions.

#### SEVERAL USES OF OSMOTIC DRAINAGE

After the physiologic basis of drainage is understood, and one grasps the principles and methods of application of glycerin osmosis, opportunities to use glycerin drainage present themselves with surprising frequency.

Lichtenstein<sup>7</sup> and others have reported most satisfactory results following the use of glycerin as a dressing in traumatic surgery.

of moisture-proof cellophane is then used to prevent hygroscopic absorption of atmospheric moisture and to protect the final bandage, the patient's clothing and

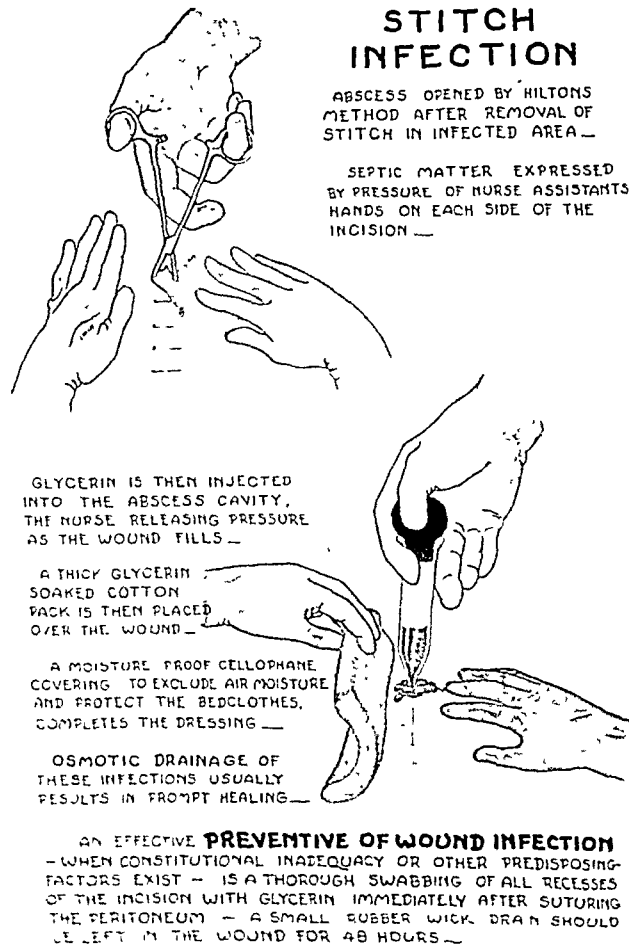


FIG. 2. Method of using osmotic drainage in treating an abscess or a potentially infected wound.

In industrial injuries, in contusions, lacerations of muscles and tendons, and in potentially infected wounds, glycerin dressings have been found so effective that for ten years their use has been routine in our office and hospital emergency work, with the result that pus as a complication of traumatic surgery has all but disappeared. The method of use is quite simple. First, a layer of single thickness gauze is spread over the injury, or tucked into all recesses of the wound if its severity dictates delayed suture. Next, generous masses of long fiber cotton are soaked with 98 per cent glycerin and placed in and completely covering the wound. An outside covering

bedding from being soaked with glycerin and evoked wound discharge. When glycerin packs are used within the abdomen, cotton is not considered safe, so gauze, which is less absorbent, or a special drain, is substituted. This type of dressing promotes freedom from tissue swelling and doubtless accounts for the comfort patients experience after even severe contusions and lacerations, and it unquestionably permits freer phagocytic and reparative function.

Even when wounds are seen after some delay, and infection has become established, glycerin packs may be expected to relieve lymphangitis, to prevent furun-

culosis—which has a tendency to develop with most wet dressings—to control the infection, and to change the pus discharge

tions must be conducted in areas difficult to sterilize and to keep clean during healing, wound infection may be prevented by

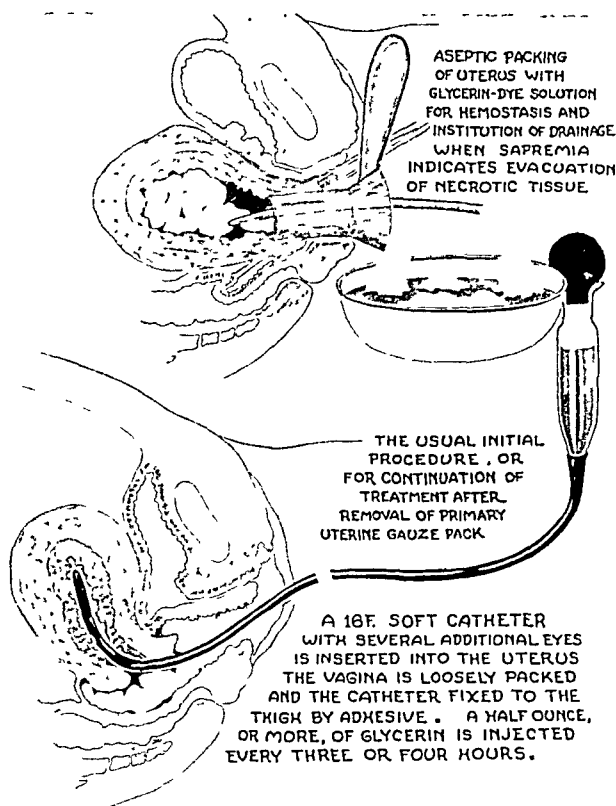


FIG. 3. Above, a method of packing the uterus which prevents contamination of the gauze and facilitates introduction of the maximum amount of glycerin. Below, modified Remington-Hobbs method of using glycerin drainage in the septic uterus. A self-retaining catheter has proved to be more satisfactory than the style illustrated.

to serum within a surprisingly short time. In frankly infected wounds of muscles, hypochlorite solution may at times be preferable to glycerin, but in fresh wounds, before deep penetration of infection—where Dakin's solution may be harmful—prompt clean healing usually results from mechanical cleansing with carbon tetrachloride and tincture of green soap, followed by a glycerin douche into the depths of the wound with a generous glycerin-soaked dressing and a day or two of delay in suturing.

In a number of conditions, as in cases necessitating considerable blunt dissection, in cases with questionable constitutional adequacy of the patient, or when opera-

pouring a jigger of glycerin into the wound and smearing it into all crevices before suturing. Hernias, scrotal and gynecologic plastics, sacrococcygeal dermoids, fractured patellas and other orthopedic operations benefit from such treatment. Particularly in vaginal operations, as for example the Mayo operation for cystocele, packing the vagina loosely with glycerin-soaked gauze through a Kelly proctoscope at the conclusion of the operation results in less fluid tension in the tissue planes, greater comfort, and a lower incidence of infection.

We have treated a few cases of chronic osteomyelitis with a free flooding of glycerin, or glycerin with an antiseptic

dye, and our impression is that healing was more rapid than following other forms of treatment.

In the cases of several extensive burns, which had developed infection and degrees of toxemia, and were unsuitable for treatment with tannic acid, prompt improvement resulted from the application of voluminous glycerin packs. The ideal treatment for extensive burns may possibly be found to be a combination of glycerin with a local anesthetic and a suitable antiseptic dye. We intend to give further study to this application of glycerin osmotherapy as case material is available.

The Remington-Hobbs<sup>8</sup> glycerin treatment of uterine sepsis has not received the acceptance it merits. We have varied the original technique, in that the catheter once placed has been left undisturbed, and a half ounce of glycerin is injected every three or four hours. This procedure is a life-saving measure in apparently desperate cases, and we believe that while sulfanilamide and osmotic drainage in conjunction are more effective in relieving postpartum infection than is either alone, yet osmotic drainage is the more essential. Temperature graphs covering periods during which one or the other or both were used furnish convincing evidence for this opinion.

In cases of cancer, free drainage and osmotic dehydration of the wound seem indicated from studies in the pathologic physiology of malignancy. Cancer cells show a definite tendency to hydremia, according to Cramer,<sup>9</sup> and withstand deprivation of water less than do normal cells. Cancer wounds, inadequately drained, become edematous, with widened lymphatic spaces and increased lymphatic tension, conditions which facilitate the permeation of cancer cells and the development of metastases. Osmotic drainage tends to reduce cancer cell hydremia, thereby weakening the cells, and, by reducing edema and lymph tension, tends to decrease the incidence of metastases by lymphatic extension. It is also apparent that cancer cells not too deep in the open

lymph channels, or cells squeezed into the wound during operative manipulations, may be washed to the drainage tract by

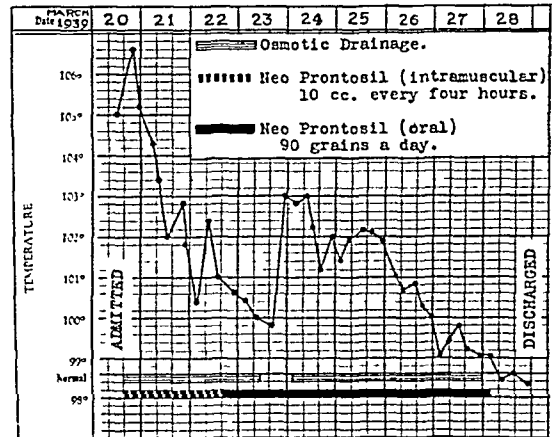


FIG. 4. Graph of temperature and periods of use of glycerin drainage and a streptostatic drug in Case A.

Summary of Case A. A para one, age 18, was admitted to the Owensboro-Daviess County Hospital March 20, 1939, with a history of an instrumental delivery March 3, 1939, followed by chills, fever and sepsis which continued. She had marked pain and rigidity in the hypogastrium, a temperature of 105° F., which rose to 106.6° F. four hours later; pulse 150. She was dehydrated from persistent vomiting. Treatment: Intravenous glucose, neoprontosil injections until the drug could be retained by mouth, and osmotic drainage by the modified Remington-Hobbs method. Note the rise in temperature on interruption of glycerin drainage.

the profuse flow of serum and be prevented from forming local recurrences.

#### OSMOTIC DRAINAGE IN ABDOMINAL INFECTION

In abdominal infections, under treatment with glycerin, there is usually a prompt shift of the temperature and pulse rates to a safe range. Considering the definite physiological indications, the simplicity and effectiveness of its use, it is strange that there does not seem to be a single reference in the available literature to the use of glycerin osmotherapy in the peritoneum.

Since reactions of the normal peritoneum to the application of glycerin hardly correspond to the effects of glycerin on edematous serous tissues, experimental studies may have been misleading. It is also



true that disappointing results have followed attempts to use some other antiseptics within the abdomen. The supe-

uting to diffusion of the infection being controlled to some degree, less plastic exudate is formed to act as bacterial pabulum,

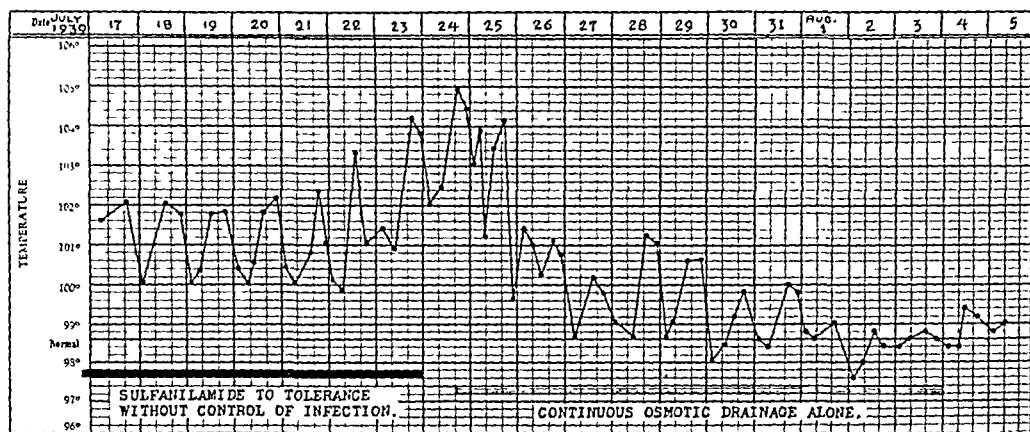


FIG. 5. Graph of temperature and periods of use of glycerin drainage and a streptostatic drug in Case B.

Summary of Case B. A para one, age 25, delivered out of the state, had septic symptoms for three weeks before returning to her Owensboro physician. Due to the development of an intolerance for sulfanilamide, which she had been receiving for three weeks, her physician instituted glycerin drainage. She had no other therapy except ferrous lextro. Note that drainage alone was quite effective in this case, but we do not recommend it be employed as the sole treatment in puerperal sepsis. Graphs of Cases A and B indicate that the use of a streptostatic drug and glycerin drainage in conjunction are more effective than either alone, but that drainage is the more essential.

riority of glycerin over other agents is shown by Hertzler's<sup>10</sup> demonstration that bichloride of mercury and iodine in the peritoneum induce an exudate in which bacteria grow splendidly, and that when bacteria and these antiseptics are introduced within the abdomen simultaneously peritonitis is more apt to develop than when bacteria are introduced alone. Irritation from these harsh antiseptics encourages bacteria more than the antiseptic power hinders their growth.

In peritonitis the local increased tension favors spread of infection through radiating lymph channels, the stagnant fluids promote bacterial growth as shown by Wegner,<sup>11</sup> and the plastic exudate acts as a culture medium for growth of organisms, the defensive efforts of the body forming hindrances to recovery. Glycerin assists in removing these handicaps by inducing fluid discharges which wash away some of the bacteria, by reducing lymphatic tension to permit freer phagocytic action, and by removing stagnant fluids. Factors contrib-

the duration of the infectious process is shortened, and consequently the number and density of permanent adhesions is reduced, for as has been shown by Hertzler,<sup>12</sup> "When an infectious process is of long duration the induced adhesions may become permanent."

Periappendiceal abscess or other established abdominal infection requires some type of mechanical drain. The selection of a drainage material, as pointed out by Horsley, should take into consideration the biologic reaction of the tissues to the material. Rubber drains act well as conduits for inflammatory products, but provoke only slight lymphatic response. On the other hand dry gauze packs excite a pronounced flow of lymph but have the disadvantage of becoming firmly fixed in the wound by the coagulation of lymph between the meshes, so that an effort to remove the gauze before this fibrin has softened, results in tearing the delicate tissues of the wound, causing bleeding. Dry gauze is therefore far from the perfect drainage material. Such a per-

fect material Horsley defines as "one which, on the one hand, is a pronounced stimulus for the lymph to be poured out along the

common bile duct. The free swabbing of glycerin over the soiled areas of the peritoneum seems to be a peritonitis prophylactic.

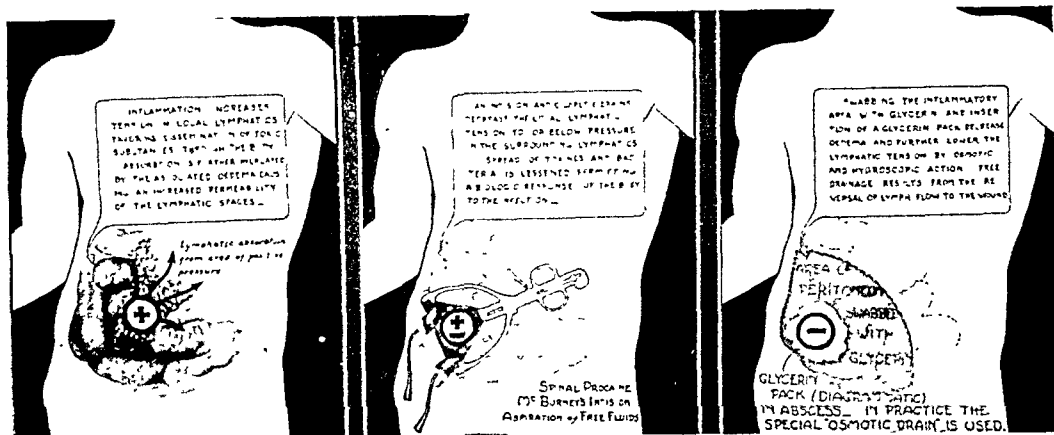


FIG. 6. Peri-appendiceal abscess. Inflammatory tension relieved by incision and osmotic drainage.

drain, and, on the other hand would not be sufficiently attached to the raw surface of the wound to injure it." Gauze thoroughly saturated with glycerin comes up to the specifications as an ideal drain since it promotes an even greater outpouring of lymph than does the dry gauze and does not adhere and cause bleeding when it is removed. For three years, whenever an abscess has been found in the lower abdomen, we have used glycerin-soaked gauze as a drain, and the results have been so consistently favorable that we undertake treatment of a case with a ruptured appendix and diffusing peritonitis with the confident expectation that the patient will recover.

To maintain a continuous profuse drainage from the abdomen we have devised a special drain which consists of a Kehrer's cigarette drain with a small catheter wrapped in its center so that glycerin may be injected down into the gauze within the abdomen.

Recently we have broadened the indications for intraperitoneal use of glycerin to include cases in which there has been accidental or unavoidable contamination of clean areas of the peritoneum, as when a gangrenous gall bladder spills, or when infected bile is smeared over the stomach and transverse colon during an operation on the

The free flow from the peritoneum, which may be anticipated following glycerin stimulation, is indicated by Schrader's<sup>13</sup> having recovered 105 c.c. of fluid from the peritoneum of a 16,000 Gm. dog forty-five minutes after injecting 25 c.c. of glycerin. Such copious discharge demands a mechanical drainage outlet and maintenance of the patient's water balance by hypodermoclysis or intravenous fluids.

While a few cases of apparently established peritonitis, with extensive distribution of fibrinous exudate, have recovered after pouring several ounces of glycerin into the abdomen and furnishing adequate drainage, no conclusion may be drawn unless these observations are supported by more clinical checks or by favorable results from the use of glycerin in induced peritonitis of laboratory animals. Glycerin drainage is not yet advocated as a cure for diffuse peritonitis, nor is it indicated when complete closure is to be done, since an osmotic agent, without a drainage outlet, would increase the stagnant fluids within the abdomen. To establish immunity in the peritoneum when judgment dictates closure of the abdomen, it is preferable to use a preparation such as coli-bactragen, as advocated by Steinberg.<sup>14</sup> The two procedures have different fields of application, though they apparently possess the same virtue of

rapidly evoking a phagocytic response from the body before the eighteen to twenty-four hours needed for bacteria to multiply sufficiently to produce recognizable peritonitis and soluble toxic substances.

#### SUMMARY

Several properties of glycerin contribute to its effectiveness as an accessory drainage agent in a variety of surgical conditions.

1. Osmotic action by reducing edema inhibits lymphatic extension of infection and increases the number of available phagocytes.

2. Hygroscopic action cleans the wound by removing discharge.

3. It is antiseptic to numerous pathogenic organisms.

4. Glycerin is relatively non-irritating and nontoxic to body cells.

5. It reduces surface tension.

6. It acts as solvent for a number of antiseptic dyes.

7. It prevents drying of the wound.

Glycerin is particularly suitable for use in infected or contaminated abdominal wounds since:

1. It reduces toxic absorption by inducing profuse drainage from the peritoneum.

2. It removes stagnant fluids and washes out wound debris.

3. Glycerin soaked drains do not adhere to endothelial tissue.

4. It tends to decrease the number of permanent adhesions.

5. It inhibits the development and diffusion of peritonitis.

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# FACTORS INVOLVED IN THE PRODUCTION OF ADHESIVE PLASTER IRRITATION\*

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THIS investigation was undertaken to study the factors which cause adhesive plaster irritations. The writer will also attempt to define adhesive plaster dermatitis, a term which has been used loosely in the past.<sup>1</sup> With the greater interest of the profession recently in the subject of allergic (contact) dermatitis, the designation allergic reaction has been carelessly applied to the manifestations of irritation of the skin occasionally caused by adhesive plaster. Furthermore, in recent months the manufacturer of one brand of adhesive plaster has made claims that his particular product is less irritating to the skin and produces fewer allergic reactions than others. It was therefore felt that a comprehensive clinical study of this problem would help to clarify the ambiguity in terminology by pointing out the nonspecific factors involved as distinguished from the allergic or specific factors.<sup>1,2,3</sup>

Several standard brands of adhesive plaster were employed under conditions simulating clinical usage. By testing each subject by the patch test technique it was possible to determine the presence of any sensitivity of allergic type. These experiments were carried out during a period when the temperature ranged from 60 to 89 degrees, and humidity from 25 to 100 per cent (June 19 to July 9, 1939), circumstances which placed the entire experiment under more severe conditions than are ordinarily present when medical or surgical strappings are applied.

Forty-eight adult subjects (twenty-four males and twenty-four females) received two separate clinical strappings (1) as for a rib fracture or pleurisy (Fig. 1) and (2) as for a lower back sprain. (Fig. 2.) Four standard brands of adhesive tape were

chosen: Bauer and Black formula 87, Bay Adhesive, Johnson and Johnson "Z.O." and Seamless Rubber. These are referred to as A, B, C, and D, but it shall not be stated in this communication which of the brands was designated by each of the four letters.

All four specimens of adhesive plaster were used for the strappings in 3 inch width strips on each subject. A was applied, with considerable tension, to the chest posteriorly beginning several inches from the spinal column on the right and continuing around to a few inches beyond the mid-sternal line on the right, thereby encircling over one half the circumference of the chest. B was applied in the same manner just below A. C extended across the lower back from the anterior superior spine on one side to the same location on the other, its upper edge being at the level of the crests of the iliac bones. D was applied just below C. At times overlapping of  $\frac{1}{2}$  to 1 inch occurred between A and B, and C and D. In order that no one brand of adhesive should have any advantage by virtue of the position on the part of the body which it occupied, a series of formulae was worked out so that each brand occupied every position six times in both male and female groups.

Patch tests with each brand of adhesive plaster were applied without tension to the lateral surfaces of each thigh in the form of strips  $2\frac{1}{2}$  to 3 inches long, and 1 inch wide, one below the other and separated by  $\frac{1}{2}$  to  $\frac{3}{4}$  inch. (Fig. 3.) They were arranged from above down in an order corresponding to the formula used for the clinical strappings.

Volunteers for the above studies consisted of hospital employees engaged as laboratory technicians and helpers, orderlies, aides, clerks, porters, and secretaries. Each subject was required to retain the

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strappings and corresponding patch tests, which were to be kept dry, for a full week, and to report at indicated intervals for

ism. No special preparation of the skin was required other than previous shaving off of hair from the areas of skin to be used, and

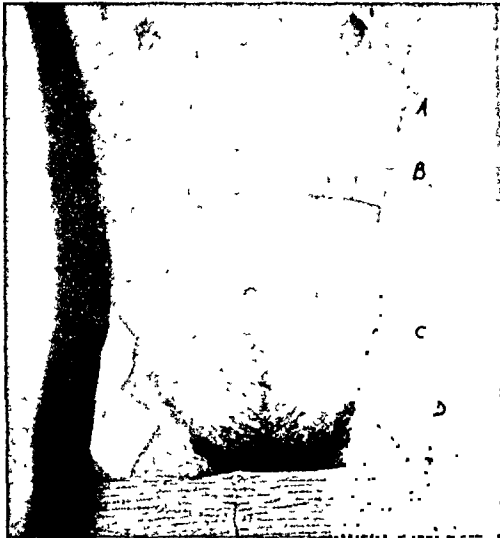


FIG. 1. Anterior view. A, B, C and D represent four standard brands of adhesive plaster; A-B, strapping for rib fracture or pleurisy; C-D, strapping for lower back sprain.



FIG. 2. Posterior view. A, B, C and D represent four standard brands of adhesive plaster; A-B, strapping for rib fracture or pleurisy; C-D, strapping for lower back sprain.

inspection. Each person was questioned as to age, occupation, personal and family history of atopic diseases, the occurrence of a contact dermatitis in the past, a history of prolonged contact with adhesive plaster and of known irritation by it. They were examined for color of the hair and its dis-

bathing on the morning when the adhesive plaster was to be applied.

#### TABULATION OF REACTIONS

The patch tests on the left thigh were removed forty-eight hours after applica-

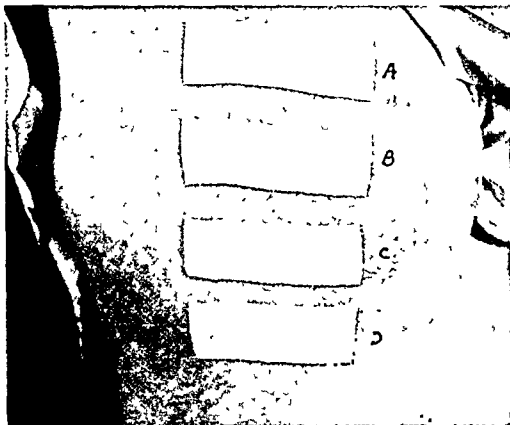


FIG. 3. Control patch tests on thighs with strips of adhesive plasters A, B, C and D.



FIG. 4. Subject No. 3, female, with fair skin. After removal of the seven-day strapings there was essentially no skin irritation (TNV = 2 to 2.5).

tribution at the sites used for adhesive plaster application. The shade of the skin was noted, and the skin was stroked over the upper back to determine dermatograph-

tion, this interval being generally recognized as the longest desirable period of contact for the conventional test. An aller-

gic adhesive plaster dermatitis, if present, would most certainly be in evidence at this time. These sites were again inspected and read four and seven days after application. The remaining patch tests (right thigh), and all the strappings were removed seven days after the initial application, and readings taken.

Prior to final removal of the strappings each subject was questioned as to whether he had suffered any discomfort such as itching, burning, pain, etc. Any evidence of irritation of the skin was recorded following removal of the adhesive plaster. Photographs of the right thigh and of the back were taken in many instances, but only those which illustrate a particular point are presented. The sites of the thigh tests and of the chest and back strappings were inspected two and four days after removal (nine and eleven day reading). In recording reactions, the writer, being unacquainted with the identity of the individual strips on each subject, called off his findings to a secretary, referring to the strips of adhesive from above down as patch 1, 2, 3, 4, or strapping, 1, 2, 3, 4.

The presence of erythema was recorded as  $E\pm$ , +, ++, or +++, depending on the degree of redness of the skin. Papules were designated by  $Pa\pm$ , +, ++, or +++. At times when papules were numerous, they were interspersed with pustules, noted as  $Pu\pm$ , +, ++, or +++. The number of pustules was always less than the papules, and was therefore included as part of the reading for the degree of papule production. Such findings as infiltration of the skin, vesiculation, and desquamation, which are commonly present with a true contact (allergic) dermatitis, were not seen in a single instance.

In order to simplify interpretation of the reactions and to eliminate the personal element in comparing the findings, the readings were recorded numerically. A single plus was given the value of 1; a plus-minus reading was graded 0.5, these evaluations applying alike to erythema, papules, or pustules. The letters NV were used to

denote the *numerical value of irritation*, e.g., NVE (for erythema) and NVPa (for Papules). By adding together NVE and NVPa the *total numerical value* (TNV) for irritation was obtained. Thus it was possible to compare adhesive plasters A, B, C, and D numerically in individual subjects or groups for the total amount of irritation produced by each. Personal interpretations did not therefore enter into the final comparisons.

Table 1 contains all the data: The first column indicates the number of the subject and the formula used in applying the four adhesive plasters. Atopy included related illnesses in the subject or his family. For past contact with adhesive plaster only those experiences were noted wherein adhesive plaster was used as a strapping over a fair-sized area of skin for at least five to seven days. The reactions produced by the four brands of adhesive plasters are recorded in the respective columns A, B, C, and D.

The two-day patch reading was obtained after removal of the patch from the left thigh (for purpose of detecting any true allergic dermatitis). Later readings of this site were not considered of sufficient importance to warrant recording. At the bottom of this column (two-day patch) is recorded the TNV in the forty-eight subjects. The seven, nine, and eleven-day readings pertain to the findings on the right thigh, and are unrelated to the two-day readings just mentioned. These values are to be compared with the seven, nine and eleven-day readings recorded under Strapping. The NVE and NVPa for each subject are recorded in the adjoining column, while the sum total of these, or TNV for forty-eight subjects are indicated at the bottom of these columns. The TNV are again recorded together at the extreme end of the table, so that the degrees of irritation in any subject or in the entire group of subjects can be compared.

Table II presents a summary of the findings for the determination of differences in response to adhesive plaster application

TABLE I

No.	Sex	Age	Occupation	Atopy	Dermatitis Venenata	Past Adhesive Plaster Contact	Stature	Hair		Skin		Remarks Concerning Strapping
								Color	Distribution	Shade	Dermographism	
1 ABCD	♂	42	Clerk	H. F. hives at 12 yrs.	0	Back 6 yrs. ago, 1 wk.	Med. ht. and wt.	Black	Sl. chest, back, thighs	Dark	E+ Uo = Urticaria neg.	Sl. itch at night.
2 ACBD	♂	31	Porter	0	0	0	Med. ht. and wt.	Med. brown	Mod. chest, thighs. None back	Med.	E+ Uo	No itch until 6th day.
3 ADBC	♂	37	Orderly	0	0	Ankle, 2 yrs. ago, several wks.	Med. ht. and wt.	Lt. brown	None chest, back sl. thighs	Fair	E+ Uo	Sl. itching last 3 days.
4 BACD	♂	32	Laundry helper	0	0	Back, 1 mo. ago, 2 wks.	Tall. Med. wt.	Lt. brown	V. sl. chest, back mod. thighs	Fair	E+ Uo	Practically no itching.
5 BCAD	♂	27	Pharmacy helper	0	0	0	Short, stout	Med. brown	None chest v. sl. back sl. thighs	Med.	E+ Uo	Sl. itching after 3rd day.
6 BDAC	♂	32	Porter	0	0	0	Med. ht., wt.	Dark brown	None chest, back sl. thighs	Med.	E± Uo	No itching. Chest strapping tight.
7 CABD	♂	23	Morgue helper	0	0	Chest 5 yrs. ago, 6 days.	Med. ht., wt.	Med. brown	St. chest, back, thighs	Fair	E+ Uo	Sl. itching chest after 4th day.
8 CBAD	♂	24	Morgue helper	0	0	Ankle, 7 yrs. ago, 10 days	Med. ht., thin	Red	V. sl. chest sl. back, mod. thighs	Fair	E+ Uo	V. Sl. itch after 5th day.
9 CDAB	♂	27	Pharmacy helper	0	0	Chest 1 yr. ago, 11 days	Med. ht., slim	Med. brown	None chest, back, v. sl. thighs	Med.	E+ Uo	Sl. itch after 3rd day.
10 DABC	♂	20	Elevator operator	0	0	Ankle, 4 yrs. ago, 2 wks. clavicle, 8 yrs. ago, 6 wks. append. 1 yr. ago	Short, slim	Dark brown	Sl. back, thighs	Med.	E+ ± Uo	V. sl. itch after 5th day.
11 DBAC	♂	19	Porter	Eczema—ears childhood	0	0	Short, med. wt.	Lt. brown	V. sl. chest, back mod. thighs	Med.	E+ ± Uo	Sl. itching on 6th day.
12 DCAB	♂	59	Orderly	0	0	0	Med. ht., wt.	Lt. brown	None	Fair	E+ + U±	No itching. Sl. tightness.
13 ABDC	♂	39	Orderly	0	0	Append. 16 yrs. ago	Tall, med. wt.	Med. brown	Sl. chest, back, thighs	Med.	E+ Uo	Sl. itching after 1st day.
14 ACDB	♂	20	Path. lab. helper	0	0	Back 5 yrs. ago, 1 wk.	Med. ht., slim	Black	Sl. back, chest mkd. thighs	Dark	E+ + Uo	Mkd. itch chest 24 hrs. after application. V. sl. itch—back.
15 ADCB	♂	18	Clerk	0	0	Abdominal injury 4 yrs. ago, 1 wk.	Short, med. wt.	Med. brown	V. sl. chest, mod. back, thighs	Med.	E± Uo	No discomfort.

	16 BADC	17 BCDA	18 BDCA	19 CADB	20 CBDA	21 CDAB	22 DACH	23 DBCA	24 DCBA	1 ABCD	2 ACHD	3 ADBC	4 BACD	5 BCAD	6 BDAC	7 CARD	8 CBAD	9 CDAB
	64	29	26	44	22	21	33	21	31	19	20	21	50	25	44	24	23	20
	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂	♂
	Porter	Clerk	Porter	Porter	Cafeteria helper	Elevator operator	Orderly	Orderly	Orderly	Aide	Aide	Lab. technician	Aide	Aide	X-ray aide	Secretary	Lab. technician	Lab. technician
							Sister has hives		Hives rarely				Father— asthma	Father— asthma			Occ. hives sis- ter, nephew asthma	
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Poison ivy last yr.	0
	0	0	0	Knee 27 yrs. ago, 2 wks.	0	0	Back, chest 1 yr. ago, 2 mos.	0	0	Ankle 3 yrs. ago, 3 days	0	0	0	0	Abdominal op- eration 4 yrs. ago	Ankle strapping 5 yrs. Fre- quently	Ankle 1 yr. ago 1 wk.	0
	Med. brown. gray	Black	Med. brown	Med. brown	Black	Med. brown	Med. brown	Med. brown	Black	Black	Dark brown	Red	Black	Black	Gray blonde	Black	Black	Black
	None chest, back, sl. thighs	V. sl. back mod. thighs	V. sl. back mod. thighs	V. Sl. thighs	None chest, Sl. back mod. thighs	Sl. chest, back mod. thighs	Sl. thighs	V. sl. back sl. thighs	Mod. chest, back, thighs	Sl. thighs	Sl. thighs	None	None	V. sl. back	None	Sl. chest, back, thighs	None	Sl. back, thigh
	Med.	Dark	Med.	Med.	Med.	Med.	Med.	Med.	Med.	Med.	Med.	Fair	Med.	Med.	Fair	Dark	Med.	Dark
	E+Uo	E+Uo	E+Uo	E±Uo	E+±Uo	E+Uo	E+±Uo	E+±Uo	E+Uo	E+±Uo	E+±Uo	E+Uo	E±Uo	E+Uo	E+Uo	E+Uo	E+±+U+	E±Uo
	V. sl. itching after 3rd day.	V. sl. itching after 3rd day.	Sl. itching last day. Tight across chest.	No complaints.	Sl. itching since appli- cation. Considerable last day.	V. sl. itching after 4th day.	V. sl. itching after 3rd day.	Sl. itching after 1st day.	Sl. itching after 4th day.	Chest itch sl. after 3rd day back not bothersome.	Sl. itching after 3rd day.	V. little itching after 3rd day.	V. sl. itching after 1st day.	V. sl. itching after 1st day.	Sl. itching 3rd & 4th days.	V. little itching after 3rd day.	Sl. itching since appli- cation, mod. last day.	Sl. itch lower back after 3rd day.



TABLE I (Continued)

TABLE I (Continued)														Остябрь
No.	Sex	Age	Occupation	Atopy	Dermatitis Venenata	Past Adhesive Plaster Contact	Stature	Hair			Skin		Remarks Concerning Strapping	
								Color	Distribution	Shade	Dermographism			
10 DABC	♂	21	Lab. technician	0	0	Append. 2 yrs. ago	Med. ht., wt.	Med. brown	Sl. back thighs	Med.	E + U <sub>0</sub>		Practically no itching.	
11 DBAC	♂	24	Aide	0	0	0	Med. ht., stout	Med. brown	None back, chest v. sl. thighs	Fair	E + U <sub>0</sub>		Sl. itching past 2 days.	
12 DCAB	♂	30	Aide	0	0	Leg 1 mo. ago 1 wk.	Med. ht., wt.	Lt. brown	V. sl. back, thighs	Fair	E ± U <sub>0</sub>		Sl. itching past 2 or 3 days.	
13 ABDC	♂	22	Aide	0	0	Back 1 yr. ago 1 wk.	Med. ht., wt.	Dark brown	Sl. lower back v. sl. thighs	Fair	E + U <sub>0</sub>		V. sl. itching after 3rd day.	
14 ACDB	♂	31	Aide	0	0	Back 1 mo.	Med. ht., wt.	Dark brown	None	Fair	E ± U <sub>0</sub>		Sl. itching 3rd night.	
15 ADCB	♂	42	Aide	0	0	0	Med. ht., wt.	Blonde	V. sl. lower back	Fair	E <sub>0</sub> U <sub>0</sub>		Mod. itching after 3rd day.	
16 BADC	♂	24	Aide	0	0	0	Med. ht., thin	Lt. brown	V. Sl. back	Fair	E + + U ±		V. sl. itching last day.	
17 BCDA	♂	28	Aide	0	0	Append. 7 yrs. ago	Short, med. wt.	Med. brown	None	Fair	E + U <sub>0</sub>		V. sl. itching after 3rd day.	
18 BDCA	♂	26	Clerk	Occasional hives	Summer rash 10 yrs.	0	Short, stout	Reddish brown	Sl. back, thighs	Dark	E + U <sub>0</sub>		Sl. itching past 3 days.	
19 CADB	♂	32	Aide	Occasional hives	0	Ankle 5 yrs. ago 1 wk.	Med. ht., wt.	Black	None	Med.	E + + U +		V. sl. itching after 2nd day.	
20 CBDA	♂	22	Lab. technician	0	0	Mastoid dressing 11 yrs. ago 3 wks.	Med. ht., wt.	Med. brown	V. sl. chest, back, thighs	Med.	E ± U <sub>0</sub>		V. sl. itching after 2nd day.	
21 CDBA	♂	19	Clerk	0	0	0	Med. ht., wt.	Lt. brown	V. sl. back thighs	Fair	E + ± U <sub>0</sub>		V. sl. itching after 3rd day.	
22 DACB	♂	20	Messenger	0	0	Ankle 3 yrs. ago 2 wks.	Short, slim	Dark brown	V. sl. thighs	Med.	E + U <sub>0</sub>		Sl. itching 1st day.	
23 DBCA	♂	22	Lab. technician	0	0	0	Short, med. wt.	Black	V. sl. chest, thighs sl. back	Med.	E ± U <sub>0</sub>		V. sl. itching since application.	
24 DCBA	♂	22	Secretary	0	0	Append. 6 yrs. ago	Med. ht., slim	Lt. brown	Sl. thighs	Fair	E + U <sub>0</sub>		Tight 1st few days. No itching.	

TABLE I (Continued)

Adhesive Plaster A												Adhesive Plaster B											
Patch						Strapping						Patch						Strapping					
No.	2 Day	7 Day	9 Day	11 Day		7 Day	9 Day	11 Day	Total	NVE	NVPa	2 Day	7 Day	9 Day	11 Day	7 Day	9 Day	11 Day	Total	NVE	NVPa		
1 ABCD	0	0	0	0		E+ Pu±	E+ Pa±	E± Pa±	3.5	3.5	1.5	0	0	0	0	E+ Pu±	E+ Pa±	E± Pa±	3.5	3.5	1.5		
2 ACBD	0	Pa±	E± Pa±	E± Pa±		E+ Pu+ +	E+ Pa+ +	E± Pa+ +	3.5	3.5	5.0	E±	E±	E+	E±	E+ Pu+ +	E+ Pa+ +	E± Pa+ +	3.0	7.5	7.5		
3 ADBC	E±	E± Pa±	0	0		Pu+ + +	E+ Pa+ +	E+ Pa+ +	2.0	3.5	7.0	E+	E+	E±	E±	Pu+ + +	E+ Pa+ +	E+ Pa+ +	2.5	7.0	7.0		
4 BACD	0	Pa±	0	.....		Pa+	Pa±	.....	0	1.5	2.0	0	Pa±	0	.....	Pa+ ±	E± Pa±	.....	0.5	2.0	2.0		
5 BCAD	E±	E+	E±	E±		E+ +	E+	E+	4.0	0	0	E+	E+	E±	E±	E±	E±	E±	3.5	0	0		
6 BDAC	0	Pa±	E±	E±		E+ ±	E±	E±	2.5	0	1.5	0	E+ ±	E±	E±	E± Pa+ +	E+ Pa±	E±	3.0	1.5	1.5		
7 CABD	0	0	E±	E±		E+ + Pa+	E+	E±	3.5	1.0	0	0	E+ + Pa+	E±	E±	0	E±	E±	1.0	0	0		
8 CBAD	E±	E± Pa±	E±	E±		E+ ± Pa±	E+ Pa±	E±	3.0	1.0	2.5	0	E+ ± Pa±	E±	E±	E+ Pa+ +	E+ Pa±	E±	2.5	1.0	1.0		
9 CDAB	0	0	E±	E±		E+	E±	E±	2.0	0	0	0	E+	E±	E±	Pu+	E+ Pa+ ±	E± Pa+ ±	1.5	2.5	2.5		
10 DABC	0	0	0	0		E± Pa+ +	E± Pa+ +	E± Pa+ +	1.5	2.5	5.0	0	E± Pa+ +	0	0	E± Pa+ +	Pu±	Pu±	0.5	5.0	5.0		
11 DBAC	E±	Pa±	0	0		Pa+ ±	Pa+ ±	Pa+ ±	0	4.5	3.0	0	Pa+ ±	E±	E±	E± Pa+ +	Pa+	Pa+	0.5	3.0	3.0		
12 DCAB	E±	E±	E±	E±		E+ ± Pa+	E± Pa+	E± Pa+	2.5	2.5	2.0	E+	E±	E±	E±	E+ Pa+ +	E± Pa±	E± Pa±	2.0	2.0	2.0		
13 ABDC	0	Pa±	E±	E±		E+ ± Pa±	E+ Pa±	E+ Pa±	3.5	1.0	2.5	0	Pa±	E±	E±	E+ Pa+ +	E+ Pa+ +	E+ Pa+ +	3.0	2.5	2.5		
14 ACDB	E±	Pa+	E± Pa±	E± Pa±		E+ + + +	E+ Pa+ +	E± Pa±	4.5	2.5	5.5	E±	Pa+	E±	E±	E+ + + +	E± Pa+ +	E± Pa+ +	3.0	5.5	5.5		
15 ADCB	E±	E± Pa±	0	0		E± Pa+ +	E± Pa+ ±	E± Pa+ ±	2.0	4.5	1.5	E±	E±	E±	0	E± Pa+ +	Pa±	0	0.5	1.5	1.5		

TABLE I (Continued)

No.	Adhesive Plaster A										Adhesive Plaster B									
	Patch					Strapping					Patch					Strapping				
	2 Day	7 Day	9 Day	11 Day	Total	2 Day	7 Day	9 Day	11 Day	NVE NVPa	2 Day	7 Day	9 Day	11 Day	Total	2 Day	7 Day	9 Day	11 Day	NVE NVPa
16 BADC	E+	E±	0	0	2.0 0.5	E±	E+ Pu±	E±	E±	2.0 0.5	E+	E±	0	0	2.0 0.5	E+	E+ Pu±	E± Pa±	E±	2.0 1.0
17 BCDA	0	0	0	0	1.5 0.5	E± Pa±	E± Pa±	0	0	1.5 0.5	0	0	0	0	1.5 0.5	E± Pa±	E+ Pa±	E± Pa±	E± Pa±	4.0 1.0
18 BDCA	E+	E+	E±	E±	3.0 2.0	E+ Pa±	E+ Pa±	E± Pa±	E± Pa±	3.0 2.0	E+	E+	E±	E±	3.0 2.0	E+ Pa±	E+ Pa±	E± Pa±	E±	1.0 1.0
19 CADB	0	0	E±	E±	2.5 4.5	E± Pa±	E± Pa±	E± Pa±	E± Pa±	2.5 4.5	0	E± Pu+	E± Pa±	E± Pa±	2.5 4.5	E± Pa±	E± Pa±	E± Pa±	E± Pa±	2.0 2.0
20 CBDA	Pa+	E± Pa±	E± Pa±	0	2.5 1.5	E± Pa±	E± Pa±	E± Pa±	0	2.5 1.5	Pa+	E± Pa±	E± Pa±	0	2.5 1.5	E± Pa±	E± Pa±	E± Pa±	0	1.5 1.5
21 CDBA	0	E± Pa±	E±	0	2.5 5.5	E± Pa±	E± Pa±	E± Pa±	E± Pa±	2.5 5.5	0	E± Pa±	E±	0	2.5 5.5	E± Pa±	E± Pa±	E± Pa±	E± Pa±	4.5 4.5
22 DACB	E±	E± Pa±	0	0	3.0 0	E+	E+	E+	0	3.0 0	E±	Pa±	0	0	3.0 0	E± Pa±	E± Pa±	E± Pa±	0	1.0 1.0
23 DBCA	Pa+	0	E±	E±	2.5 3.0	E+ Pa±	E+ Pa±	E+ Pa±	E± Pa±	2.5 3.0	Pa+	0	E±	E±	2.5 3.0	E+ Pa±	E+ Pa±	E+	E±	0.5 0.5
24 DCBA	E+	E+	E±	E±	4.5 2.5	E+ Pa±	E+ Pa±	E+ Pa±	E± Pa±	4.5 2.5	E±	E+	E±	E±	4.5 2.5	E+ Pa±	E+ Pa±	E± Pa±	E± Pa±	3.0 3.0
1 ABCD	0	0	0	0	2.5 0	E+	E+	E+	E±	2.5 0	0	0	0	0	2.5 0	E+	E+	E+	E±	0 0
2 ACBD	E±	Pu+	Pa+	E± Pa+	2.0 5.5	E± Pa±	E± Pa±	E± Pa±	E± Pa±	2.0 5.5	0	Pa±	Pa±	E± Pa±	2.0 5.5	E± Pa±	E+ Pa±	E± Pa±	E± Pa±	7.0 7.0
3 ADBC	0	E±	E±	E±	2.0 0	E±	E±	E±	E±	2.0 0	0	E±	E±	E±	2.0 0	E±	E±	E±	E±	0 0
4 BACD	0 RR	E±	0	0	1.0 0	E+	E+	0	0	1.0 0	0	E±	0	0	1.0 0	E+	E+	0	0	0 0
5 BCAD	0	0	E±	E±	1.0 3.0	Pa+	E+ Pa+	Pa+	Pa+	1.0 3.0	0	0	E±	E±	1.0 3.0	E+ Pa+	E+ Pa+	E+ Pa+	E+ Pa+	3.5 3.5
6 BDAC	0	0	E±	0	1.0 1.0	E± Pa±	E± Pa±	E± Pa±	0	1.0 1.0	E+ Pa+	0	E±	0	1.0 1.0	E+ Pa±	E+ Pa±	E+ Pa±	0	3.0 3.0

$\sim$ $CADD$	$E_1$	$E_2$	$E_3$	$0$	$E_1 \pm$	$E_2 \pm$	$E_3 \pm$	$0$	$E_1 +$	$E_2 +$	$E_3 +$	$0$	$E_1 \pm$	$E_2 \pm$	$E_3 \pm$	$0$	$E_1 +$	$E_2 +$	$E_3 +$	$0$	$2.0$	$0$																																																																																																																																																																						
$^8$ $CHAD$	$E_1$	$0$	$0$	$0$	$P_1 \pm$	$0$	$0$	$0$	$1.5$	$2.0$	$1.5$	$0$	$0$	$0$	$0$	$0$	$E_1$	$E_2$	$E_3$	$E_1 \pm$ $P_2 + +$	$2.0$	$3.0$																																																																																																																																																																						
$^9$ $CDAB$	$0$	$P_1 \pm$	$0$	$0$	$P_1 + +$	$E_2 \pm$ $P_3 +$	$0$	$3.5$	$0.5$	$0$	$P_1 +$	$0$	$P_1 \pm$	$0$	$0$	$0$	$P_1 +$	$0$	$P_1 \pm$	$E_2 \pm$ $P_3 \pm$	$0.5$	$2.5$																																																																																																																																																																						
$^{10}$ $DABC$	$E_1$	$0$	$0$	$0$	$P_1 \pm$	$0$	$0$	$1.5$	$2.0$	$0$	$E_1 +$	$0$	$0$	$0$	$0$	$0$	$E_1 +$	$0$	$P_1 \pm$	$0$	$2.0$	$0.5$																																																																																																																																																																						
$^{11}$ $DBAC$	$0$	$0$	$0$	$0$	$E_2 \pm$ $P_3 \pm$	$P_1 \pm$	$0$	$1.0$	$0.5$	$0$	$E_2 \pm$ $P_3 +$	$0$	$0$	$0$	$0$	$0$	$E_2 \pm$ $P_3 +$	$0$	$E_2 \pm$ $P_3 \pm$	$E_2 \pm$ $P_3 \pm$	$1.5$	$2.5$																																																																																																																																																																						
$^{12}$ $DCAB$	$E_1$	$E_2 \pm$	$E_3$	$E_2 \pm$	$P_1 + +$	$E_2 \pm$ $P_3 +$	$E_3$	$2.0$	$5.0$	$E_1 +$	$E_1 +$	$E_2 \pm$	$E_2 \pm$	$P_1 \pm$	$0$	$0$	$E_1 +$	$E_2 \pm$	$E_3$	$P_1 + +$ $P_2 \pm$	$2.0$	$5.5$																																																																																																																																																																						
$^{13}$ $ABDC$	$0$	$0$	$0$	$0$	$E_2 \pm$ $P_3 +$	$P_1 + \pm$	$E_3$	$1.0$	$4.5$	$0$	$E_2 \pm$ $P_3 +$	$0$	$0$	$0$	$0$	$0$	$E_2 \pm$ $P_3 +$	$0$	$P_1 +$	$E_2 \pm$ $P_3 +$	$1.0$	$3.0$																																																																																																																																																																						
$^{14}$ $ACDB$	$E_2$	$0$	$0$	$0$	$E_2 \pm$	$0$	$0$	$1.0$	$0$	$0$	$E_2 \pm$	$0$	$0$	$0$	$0$	$0$	$E_2 \pm$	$0$	$P_1 \pm$	$P_1 \pm$	$1.0$	$1.5$																																																																																																																																																																						
$^{15}$ $ADCB$	$0$	$E_2 \pm$ $P_3 +$	$E_2 \pm$	$0$	$E_2 \pm$	$0$	$E_2 \pm$	$2.5$	$0$	$0$	$E_2 \pm$	$0$	$E_2 \pm$	$E_2 \pm$	$E_2 \pm$	$0$	$E_2 \pm$	$0$	$E_2 \pm$ $P_3 +$	$0$	$1.5$	$1.5$																																																																																																																																																																						
$^{16}$ $BADC$	$E_2$	$E_1$	$E_2 \pm$	$E_2 \pm$	$E_2 \pm$	$E_2 \pm$	$E_2 \pm$	$3.0$	$0$	$E_2 \pm$	$E_2 \pm$	$E_2 \pm$	$E_2 \pm$	$E_2 \pm$	$E_2 \pm$	$0$	$E_2 \pm$	$0$	$E_2 \pm$	$E_2 \pm$	$3.0$	$0$																																																																																																																																																																						
$^{17}$ $BCDA$	$0$	$E_2 \pm$	$0$	$0$	$E_2 \pm$ $P_3 \pm$	$E_2 \pm$ $P_3 \pm$	$E_2 \pm$	$1.0$	$1.0$	$0$	$E_2 \pm$	$0$	$E_2 \pm$	$E_2 \pm$	$E_2 \pm$	$0$	$E_2 \pm$	$0$	$E_2 \pm$ $P_3 +$	$E_2 \pm$ $P_3 +$	$1.5$	$2.0$																																																																																																																																																																						
$^{18}$ $BDCA$	$0$	$E_2 \pm$	$E_2 \pm$	$E_2 \pm$	$P_1 \pm$	$P_1 \pm$	$E_2 \pm$	$1.0$	$2.0$	$0$	$E_2 \pm$	$0$	$E_2 \pm$	$E_2 \pm$	$E_2 \pm$	$0$	$E_2 \pm$	$0$	$E_2 \pm$ $P_2 + +$ $P_3 +$	$E_2 \pm$ $P_2 + +$ $P_3 +$	$2.0$	$3.5$																																																																																																																																																																						
$^{19}$ $CADB$	$0$	$0$	$0$	$0$	$0$	$0$	$0$	$2.0$	$0$	$0$	$E_2 \pm$	$0$	$E_2 \pm$	$0$	$0$	$0$	$E_2 \pm$	$0$	$0$	$0$	$2.0$	$0$																																																																																																																																																																						
$^{20}$ $CBDA$	$E_1$	$E_1$	$0$	$0$	$E_2 \pm$	$E_2 \pm$	$E_2 \pm$	$2.5$	$0.5$	$E_2 \pm$	$0$	$0$	$E_2 \pm$	$0$	$0$	$0$	$E_2 \pm$	$0$	$E_2 \pm$	$E_2 \pm$	$1.5$	$0.5$																																																																																																																																																																						
$^{21}$ $CDBA$	$E_2 \pm$	$E_2 \pm$ $P_3 \pm$	$E_2 \pm$	$0$	$E_2 \pm$	$0$	$E_2 \pm$	$2.0$	$0$	$0$	$E_2 \pm$	$0$	$E_2 \pm$	$E_2 \pm$	$E_2 \pm$	$0$	$E_2 \pm$	$0$	$E_2 \pm$	$0$	$2.0$	$0.5$																																																																																																																																																																						
$^{22}$ $DACB$	$E_2 \pm$	$0$	$0$	$0$	$E_2 \pm$ $P_3 \pm$	$E_2 \pm$ $P_3 \pm$	$E_2 \pm$	$1.5$	$2.0$	$E_2 \pm$	$0$	$0$	$E_2 \pm$	$0$	$0$	$0$	$E_2 \pm$	$0$	$E_2 \pm$ $P_2 + +$ $P_3 \pm$	$E_2 \pm$ $P_2 + +$ $P_3 \pm$	$2.0$	$3.5$																																																																																																																																																																						
$^{23}$ $DBCA$	$E_1$	$0$	$0$	$0$	$E_2 \pm$	$0$	$0$	$0.5$	$4.0$	$0$	$E_2 \pm$	$0$	$0$	$0$	$0$	$0$	$E_2 \pm$	$0$	$P_1 + +$ $P_2 \pm$ $P_3 + +$	$E_2 \pm$ $P_1 + +$ $P_2 \pm$ $P_3 + +$	$1.0$	$6.0$																																																																																																																																																																						
$^{24}$ $DCBA$	$0$	$E_2 \pm$	$E_2 \pm$	$E_2 \pm$	$E_2 \pm$	$0$	$E_2 \pm$	$2.0$	$0$	$0$	$E_2 \pm$	$0$	$E_2 \pm$	$E_2 \pm$	$E_2 \pm$	$0$	$E_2 \pm$	$0$	$0$	$0$	$1.0$	$0$																																																																																																																																																																						
$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$																																																																																																																																																																						
																			$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*}5$	$1^{*$

TABLE I (Continued)

Adhesive Plaster C												Adhesive Plaster D												Numerical Value of Irritation (TNV)			
Patch												Strapping												Strapping			
No.	2 Day	7 Day	9 Day	11 Day	7 Day	9 Day	11 Day	Total NVE	Total NVPa	2 Day	7 Day	9 Day	11 Day	7 Day	9 Day	11 Day	9 Day	11 Day	9 Day	11 Day	9 Day	11 Day	A	B	C	D	
1 ABCD	0	0	0	0	E±	0	0	0.5	0	0	0	0	0	E±	0	0	0	0	0	0.5	0	0.5	5.0	5.0	0.5	0.5	
2 ACBD	0	0	E+	E±	E+ Pu++	E+ Pu++	E+ Pu++	3.0	5.0	0	E±	E+	E±	E+ Pu++±	E± Pu++±	E± Pu++±	E± Pu++±	E± Pu++±	E± Pu++±	3.0	7.5	8.5	10.5	8.0	10.5		
3 ADBC	E+	E±	E±	0	E± Pu++	E± Pu++	E± Pu++	2.0	3.5	E+	E+	E±	E±	Pu++	E+ Pu++	E+ Pu++	E+ Pu++	E+ Pu++	E+ Pu++	2.0	4.5	5.5	9.5	5.5	6.5		
4 BACD	0	Pa±	E± Pa±	.....	Pa+	.....	.....	0	1.5	0	Pa±	E±	.....	Pa±±	Pa±	.....	.....	.....	.....	0	2.5	1.5	2.5	1.5	2.5		
5 BCAD	E+	E+	E±	E±	E±	E±	E±	3.5	0	E+	E+	E±	E±	E±	E+	E+	E+	E+	E+	4.0	0	3.5	3.5	4.0			
6 BDAC	0	Pa±	E±	E±	Pa±	Pa±	Pa±	0.5	0.5	0	Pa±	E±	E±	E± Pa±	E± Pa±	E± Pa±	E± Pa±	E± Pa±	E± Pa±	2.5	1.0	2.5	4.5	1.0	3.5		
7 CABD	0	Pa±	E±	E±	E+ Pa+	E+ Pa+	E±	1.0	1.0	0	Pa±	E±	E±	E± Pa±	E± Pa±	E± Pa±	E± Pa±	E± Pa±	E± Pa±	2.0	1.5	4.5	1.0	5.0	3.5		
8 CBAD	0	E± Pa+	E± Pa+	E±	E±	E+	E±	2.5	0	E±	E±	E+	E±	E+ Pa±	E+ Pa±	E±	E+ Pa±	E±	E±	3.0	1.0	4.0	3.5	2.5	4.0		
9 CDAB	0	Pa±	E±	E±	Pu++	Pu++	Pu++	2.0	5.0	0	Pa±	E±	E±	Pu++	E+ Pu++	E+ Pu++	E+ Pu++	E+ Pu++	E+ Pu++	2.0	5.0	2.0	4.0	7.0			
10 DABC	0	0	0	0	E± Pa±	E± Pa±	E± Pa±	0.5	5.0	0	0	0	0	E+ Pa±	E+ Pa±	E+ Pa±	E+ Pa±	E+ Pa±	E+ Pa±	2.0	4.0	4.0	5.5	5.5	6.0		
11 DBAC	0	0	0	0	Pa±	Pa±	Pa±	0	3.0	0	Pa±	E±	E±	Pa±	Pa±	Pa±	Pa±	Pa±	Pa±	0	1.5	4.5	3.5	3.0	1.5		
12 DCAB	E±	E±	E±	E±	E+ Pa+	E+ Pa+	E± Pa±	3.5	2.5	E±	E±	0	0	E+ Pa+	E+ Pa+	E± Pa±	E+ Pa+	E+ Pa+	E+ Pa+	3.5	2.5	5.0	4.0	6.0	6.0		
13 ABDC	0	E± Pa±	E±	E±	E+ Pa+	E± Pa+	E± Pa±	2.5	2.5	0	Pa±	E±	E±	E+ Pa±	E± Pa±	E± Pa±	E± Pa±	E± Pa±	E± Pa±	2.5	1.0	4.5	5.5	5.0	3.5		
14 ACDB	E±	Pa+	E± Pa±	E± Pa±	E+ Pa+	E± Pa+	E± Pa±	3.0	2.5	E±	Pa+	E±	E±	E+ Pa+	E± Pa+	E± Pa+	E± Pa+	E± Pa+	E± Pa+	4.0	4.5	7.0	8.5	5.5	8.5		
15 ADCB	E±	E±	0	0	E± Pa±	E± Pa±	E± Pa±	1.0	0.5	E±	E± Pa±	0	0	E± Pa±	E± Pa±	E± Pa±	E± Pa±	E± Pa±	E± Pa±	2.0	3.5	6.5	2.0	1.5	5.5		

$10$ BADC	$11$ BCDA	$12$ BDCA	$13$ CBDA	$14$ CDBA	$15$ DABC	$16$ DBAC	$17$ DCBA	$18$ ACBD	$19$ ADBC	$20$ BACD	$21$ BCAD	$22$ BDAC	$23$ CADB	$24$ CBAD	$25$ CDAB	$26$ DABC
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$	$16$	$17$	$18$	$19$	$20$	$21$	$22$	$23$	$24$	$25$	$26$
$10$	$11$	$12$	$13$	$14$	$15$											



TABLE II  
NUMERICAL VALUES (N.V.) OF IRRITATION PRODUCED BY FOUR BRANDS OF ADHESIVE PLASTER

Subjects, Days	A						B						C						D											
	24 Male			24 Female			24 Male			24 Female			24 Male			24 Female			24 Male			24 Female			Total					
	NVE			NVPa			NVE			NVPa			NVE			NVPa			NVE			NVPa			TNV			TNV		
	TNV			TNV			TNV			TNV			TNV			TNV			TNV			TNV			TNV			TNV		
Patches:																														
7	7	7	6	3.5	23.5	8	5.5	6	3	22.5	7.5	7	24.5	25.5	13	4.5	3.5	8.5	6.5	6	5.5	3	24.0							
0	7.5	1.5	5.5	2	16.5	10	1.5	5.5	0.5	17.5	9	2.5	18.5	9.5	1.5	5.5	1.5	9.5	0.5	5.5	0.5	16.0								
11	6.5	1	3.5	1	12.0	7.5	1.0	3.5	0.5	12.5	6.5	0.5	11.5	7	1.0	3.5	7	0	4.0	0.5	11.5									
TNV -48 subjects					52.0					52.5													51.5							
Strappings:																														
7	29	21.5	26.5	13.5	90.5	19	27	26.5	19	91.5	24	24.5	24.5	25.5	13	25.5	13	26	23.5	26	17.5	17.5	93.0							
0	19	17.5	7	11	54.5	19	21.5	9	18	67.5	15	18.5	18.5	9.5	11.5	9.5	11.5	17.5	19.5	7.5	17.5	62.0								
11	14	11	5	11.5	41.0	13	13.5	8.5	12.5	47.5	12.5	11.5	11.5	7	9.5	7	9.5	11.5	11	5.5	11.5	39.5								
TNV -48 subjects.					186.0					206.5													194.5							

between males and females. The amount of irritation in evidence at any one reading in any subject is indicated. In Table III are compared the TNV of patch tests with the TNV of strappings for each adhesive in the entire group of forty-eight subjects.

TABLE III  
COMPARISON OF TNV

	Patches			Strappings		
	24 Male	24 Female	48 Total	24 Male	24 Female	48 Total
A	30.5	21.5	52.0	112	74.0	186.0
B	33.5	19.0	52.5	113	93.5	206.5
C	33.0	19.5	52.5	106	76.0	182.0
D	32.0	19.5	51.5	109	85.5	194.5

The TNV for strappings were as follows: A, 186.0; B, 206.5; C, 182.0; D, 194.5. It is obvious that the irritations produced by the brands of adhesive plaster varied very little. The highest TNV in any one subject, namely 8.5 for A, 10.5 for B, 8.0 for C, and 10.5 for D occurred in a porter, age 31 (2, male, Table I). The lowest TNV, namely 1.0 for A, 1.0 for B, 0 for C, and 0 for D was found in an aide, age 50 (4, female).

The TNV for the 7-day patch tests were as follows: A, 52.0; B, 52.5; C, 52.5; D, 51.5. There was essentially no difference in the final values. The TNV for the two-day patch tests (left thigh) were as follows: A, 17.5; B, 15.0; C, 12.5; D, 14.0. (Table I.)

An attempt was made to correlate those facts obtained from the history or examination of the subjects with the experimental results just noted. In regard to age, the males ranged from 19 to 64 years, most being between 20 and 35 years. The females ranged from 19 to 50 years, most of them between 20 and 30 years. Inasmuch as the subjects were mainly young adults, it was not possible to compare age groups.

The female subjects showed smaller TNV than the males, e.g., the patches in the former varied from 19.0 to 31.5 while in the latter these values were 30.5 to 33.5. The TNV for the strappings in the female



group ranged from 74.0 to 93.5 while in the male subjects these readings varied from 106.0 to 113.0. It seemed to the writer that the work done by the men, most of them porters and orderlies, was a factor in explaining this difference in values.

Twenty-five of the forty-eight subjects had had prolonged contact in the past with adhesive plaster, in strapping of ankle, back, chest, or laparotomy, etc. However, it was not possible to correlate these contacts with the results obtained in this study. For example, an elevator operator, 20 years of age, who had had a clavicle strapping eight years before for a period of six weeks, an ankle strapping four years before for two weeks, and an appendectomy dressing one year before, gave TNV readings of 4.0 to 6.0, which are average readings for the entire group (10, male). However, the subject giving the highest TNV, 8.5 to 10.5, had never previously had any prolonged contact with adhesive (2, male).

There was no correlation with personal or family history of atopy. One subject (11, male) with eczema of the ears in childhood gave the fairly low TNV of 1.5 to 4.5. Four subjects with occasional hives, and three with a positive family history of allergy did not reveal any abnormal findings.

In two subjects (22, male and 8, female) who had had poison ivy the TNV were from 2.0 to 3.5 and 3.5 to 5.0, respectively. One subject (18, female) who had had a recurring dermatitis of various portions of the body for ten summers past, gave TNV of 2.0 to 5.5. These were all average values.

There was no correlation between the presence of plaster irritation and the color of the hair in the subject. Areas of skin covered by hair did not show more irritation than did areas of skin without hair, though more subjective discomfort was at times present.

It is commonly believed that the fairer the skin, the greater the adhesive plaster irritation. Seeliger<sup>4</sup> pointed out that subjects with light skin and blond hair reacted most, while those with strongly pigmented skin and dark hair reacted least. The pres-

ent study, however, did not give evidence of any general relationship between the shade of skin and degree of irritation. For example, a 21 year old subject with very fair skin and light red hair gave a TNV of 2.0 to 2.5 (3, female, Fig. 4), while a 22 year old subject with black hair and a medium to dark shade skin gave TNV of 4.5 to 7.0 (23, female, Fig. 5A); also a 20 year old subject with black hair and dark skin had TNV of 5.5 to 8.5 (14, male). In fact, the strongest irritation was often found among the dark skinned.

Each subject was tested for dermagraphism by stroking the skin between the scapulae with the edge of a tongue depressor. The degree of erythema ranged from  $\pm$  to  $+++$ . In general the erythema found on removal of the patch or strapping was either the same or slightly greater in degree than that shown by the stroke test. Minimal amounts of whealing (U) were produced in only four subjects, who did not as a group show more irritation than the others. The stroke reaction, moreover, bore no relation to the amount of itching or discomfort due to the strappings.

Other findings not falling into the general headings just discussed are worth mentioning. The height of skin reaction was present during the first twenty-four hours after removal of the plaster, the irritation subsiding rapidly thereafter. Table 11 shows that the TNV are less on the ninth than on the seventh day, and least on the eleventh day. In two instances, however, there was more irritation at some sites on the ninth than on the seventh day, the irritation subsiding as usual thereafter (2 and 12, female). In addition, where papules were numerous, pustules were usually scattered among them (10, male). As a rule the pustules regressed within forty-eight hours of their appearance, becoming smaller in size. The strongest papulopustular eruptions seemed to occur in those individuals whose skin showed excessive oiliness, the presence of comedones, or evidence of old acne (9, 14, and 20, male).

The marked difference in some subjects between TNV for patch test and for strappings is particularly striking where the irri-

chest with relatively little discomfort. All subjects, however, showed varying degrees of reaction to the four brands of adhesive

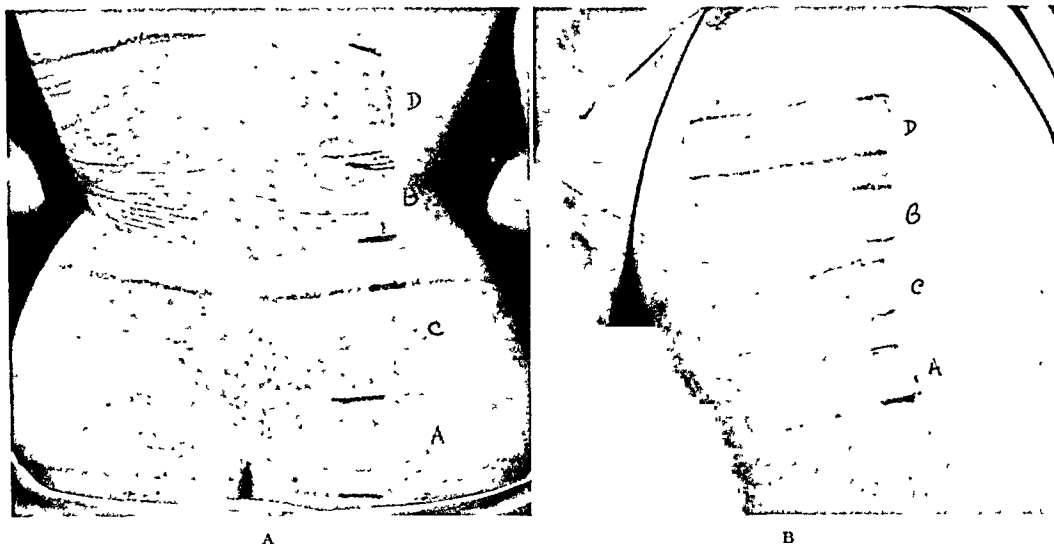


FIG. 5. A and B. Subject No. 23, female, with dark skin. Shows marked difference in same subject in irritation following removal of seven-day strappings (TNV 4.5 to 7.0) and of seven-day patch tests (TNV = 0).

tation from the latter was the greatest. In subject 17, male, the TNV for patch test was 0 and for strapping 1.5 to 7.0, and in subject 23, female (Fig. 5A and B), the values were 0 and 4.5 to 7, respectively.

In many instances the adhesive plaster at the end of the seven day period of strapping showed a punctate mottling (Fig. 6), the dark spots corresponding to small plugs of fatty material which had been pulled away from the openings of the sebaceous glands of the skin by the sticky adhesive mass. This is an evidence that oily secretions from the skin are retained under the adhesive plaster.

#### DISCUSSION

A forty-eight-hour patch test with specimens of four standard commercial brands of adhesive plaster on forty-eight normal male and female subjects was negative for a reaction signifying allergic dermatitis due to adhesive. In fact should any of these subjects have been specifically sensitive, a contact of twenty-four hours or less would have been more than adequate to elicit a typical reaction. These forty-eight subjects tolerated a 7-day strapping to the back and

plaster used in the strappings. This irritation lacked the clinical appearance of a specific dermatitis (papules, infiltration,

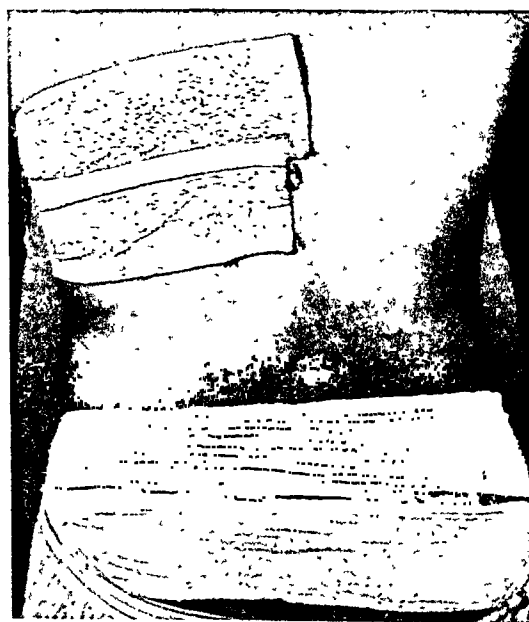


FIG. 6. Punctate mottling of adhesive plaster produced by oily secretions from sebaceous glands of skin.

vesicles). Moreover it began to subside rapidly within twenty-four hours of removal of the plaster, in contrast to the in-

crease in intensity of reaction which occurs in a specific dermatitis.

The difference between TNV of 51.5–52.5 for the seven day patch test and 182–206.5 for the clinical strappings can be explained by factors introduced when a large area of skin is covered and put under tension by a relatively impermeable foreign membrane: retention of sweat and oily secretions of the skin; maceration by friction; skin infection; chemical changes in the skin; trauma to skin capillaries, etc.

While the subject of contact dermatitis in general cannot be discussed in any detail in this communication, it will suffice here to mention a few criteria for establishing a diagnosis of allergic dermatitis due to adhesive plaster. They are (a) the application of adhesive plaster for twenty-four hours or less, producing a reaction localized to the site of contact and characterized by intense erythema, edema of the skin, and tiny or larger vesicles; rarely the reaction may spread beyond the limits of contact; (b) during the first few days after the removal of the plaster, the reaction usually becomes more intensified; (c) typical specific reactions are obtained by patch test with the known excitants in plaster mass, namely resin and rubber, and possibly others; (d) a history is obtained in many instances of contact dermatitis in the past due to other excitants. There is a low incidence of this condition in the general population. These criteria must be considered before one can rightfully make a diagnosis of a specific (allergic) dermatitis due to adhesive plaster.

In the present study not a single instance of specific dermatitis was encountered.

Most subjects showed some degree of non-specific irritation. No one brand of adhesive plaster seemed to be more productive of irritation than any other brand. Thus it was not possible to substantiate the claims of one manufacturer of adhesive plaster, either by actual test or by definition, that his product was less irritating and produced fewer allergic reactions than others.

#### CONCLUSION

The factors producing adhesive plaster irritation were studied by comparing in forty-eight subjects the effects on the skin of actual clinical strappings with the effects produced by patch test applications with the same adhesive plasters. Four standard commercial brands were used, (Bauer and Black formula 87, Bay, Johnson & Johnson "Z.O.," and Seamless Rubber). Not a single instance of specific dermatitis was encountered. It was determined that there was very little difference in the degree of irritation produced by each of the four brands. It is apparent that a certain amount of nonspecific irritation by adhesive plaster cannot be avoided. The distinction between specific and nonspecific dermatitis due to adhesive plaster is pointed out.

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# THE USE OF NEOSYNEPHRIN HYDROCHLORIDE IN MAINTAINING BLOOD PRESSURE DURING SPINAL ANESTHESIA\*†

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ONE of the major problems in spinal anesthesia is the constantly falling blood pressure. Epinephrine and ephedrine, especially the latter, have been used to preserve its stability. Both are sympathomimetic drugs and raise the blood pressure primarily by a vasoconstriction. With therapeutic dosage they increase the efficiency of the heart and cause an increase in the cardiac rate. The main objection to both during spinal anesthesia is their stimulating effect on the central nervous system. Epinephrine, particularly in moderately large doses, also increases the irritability of the heart and predisposes it to various types of arrhythmia. Ventricular fibrillation and pulmonary edema have been reported after its use.<sup>7,8</sup> Ephedrine also stimulates the central nervous system and may produce palpitation, throbbing of the head and even a reversal of its original action.<sup>7</sup> Lastly, epinephrine is not well suited because its action is of such short duration.

Neosynephrin hydrochloride is a synthetic drug resembling epinephrine and ephedrine both structurally and pharmacologically. Figure 1 shows that the essential difference between epinephrine and neosynephrin is the additional hydroxyl group contained in the benzene ring of the former. This difference may account for the stability of neosynephrin hydrochloride, which may be sterilized by boiling.

As would be expected from its close relationship to epinephrine and ephedrine, neosynephrin also causes a rise in blood pressure as effectively as ephedrine without stimulating the central nervous system and without a resulting tachycardia. On the

contrary, neosynephrin, when injected subcutaneously in normal subjects produces a definite bradycardia.

Brunner and de Takats,<sup>5</sup> in their series of 163 cases of spinal anesthesia using neosynephrin hydrochloride to stabilize blood pressure, found that no anxiety or nervousness was produced. Also they observed that neosynephrin was just as effective as ephedrine in raising or maintaining a falling blood pressure. The action of neosynephrin is manifest even after repeated doses. Johnson<sup>3</sup> gave twenty-two injections of neosynephrin in therapeutic dosage to a patient in postoperative shock and each time produced a rise in blood pressure. The intervals between injections varied from twenty to twenty-five minutes. This patient went on to recovery.

TABLE I

Hemorrhoidectomy	9
Colostomy	9
Rectal fistulectomy	8
Herniorrhaphy	5
Exploratory laparotomy	4
Repair of colostomy	4
Incision of rectal abscess	2
Hemorrhoidectomy and fistulectomy	2
Epididymectomy and orchidectomy	1
Cystostomy	1
Abdominal perineal resection (cancer of rectum)	1
Perineal resection of rectum	1
Excision of anal ulcer	1
Excision of rectal polyp	1
Excision of pilonidal cyst	1

Johnson also states that the fatal dose of neosynephrin hydrochloride, as determined by intravenous injections in dogs, is about 250 mg. per Kg. The fatal dose of ephedrine is roughly one-third and that of epinephrine one-forty-seventh of that amount.<sup>1,3</sup>

\* From the Proctologic Service, Atlantic City Hospital.

† Read before the Proctologic Society, Graduate Hospital, University of Pennsylvania, December 13, 1939.

In our series of fifty cases of spinal anesthesia using neosynephrin hydrochloride as a vasoconstrictor, we were impressed by

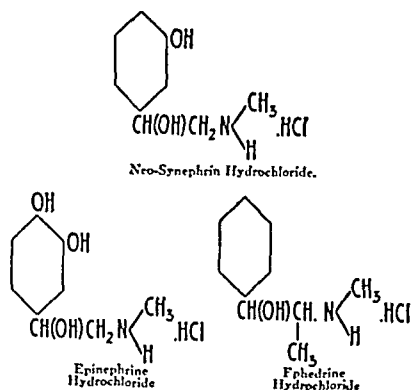


FIG. 1. Demonstrating the similarity between neosynephrin, epinephrine and ephedrine hydrochlorides. As shown by their structural formulae.

the ready and repeated response of the blood pressure; the bradycardia and the lack of arrhythmia; and the absence of nervousness or anxiety on the part of the patient. The cases reported are mainly from the proctologic department, but several cases of serious illness from the surgical and urological departments are included. (Table 1.)

In the fifty cases there were seven postoperative deaths. One patient, 73 years of age, with a history of previous auricular fibrillation, died on the eighth postoperative day of acute cardiac decompensation. One died of coronary occlusion on the seventh postoperative day. Two patients died with generalized peritonitis. Both had strangulated herniae for more than twenty-four hours before operation and one had a ruptured gangrenous appendix contained in the hernia sac. One patient with cancer of the colon died on the seventeenth postoperative day; at operation she was deemed beyond surgical aid and had been immediately closed up. Two patients died of peritonitis following operations for relief of intestinal obstruction. Both were markedly debilitated, anemic—poor operative risks, one because of cancer of the colon with obstruction and widespread metastases, and the other because of lymphopathia vene-

reum with necrosis and abscess formation extending up and including portions of the descending colon.

In all of our cases we used neocaine and pontocaine for anesthesia, either singly or together.

In 50 per cent of the cases the level of anesthesia extended to the umbilicus. In 22 per cent the level extended to a point midway between the umbilicus and the costal margin, and in 28 per cent the level extended to the costal margin or higher.

The minimum dosage in the series was 60 mg. of neocaine dissolved in 2 c.c. of spinal fluid. The average dosage was 95 mg. of neocaine dissolved in 3.5 c.c. of spinal fluid, with the maximum 75 mg. of neocaine and 17 mg. of pontocaine in 4 c.c. of spinal fluid. In ten cases neocaine and pontocaine were given together and in two cases pontocaine was given alone.

Preoperative medication consisted of 3.5 gr. of sodium allurate the evening before the day of operation, repeated two to three hours before operation. One-half hour before operation  $\frac{1}{6}$  gr. of morphine sulfate and  $\frac{1}{150}$  gr. scopolamine hydrochloride were given. In the rectal cases, the scopolamine was omitted. With this procedure, the patients were generally sleeping when brought to the operating room and seldom felt the spinal puncture or knew the operation was in progress.

The neosynephrin hydrochloride was mixed with 1 per cent novocaine and given subcutaneously and intramuscularly over the site chosen for the spinal puncture. One half c.c. of 1 per cent neosynephrin hydrochloride was the initial dosage in all cases of this series. The administration of the spinal anesthesia followed in five to ten minutes. Blood pressure and pulse were taken when the patient reached the floor, immediately after the spinal anesthesia had been given, and every five minutes thereafter.

The average initial rise in blood pressure, approximately 20 points, occurred ten to fifteen minutes after the injection of the neosynephrin and lasted twenty-five to

thirty minutes. In one case the initial rise was 75 points.

The average blood pressure was higher

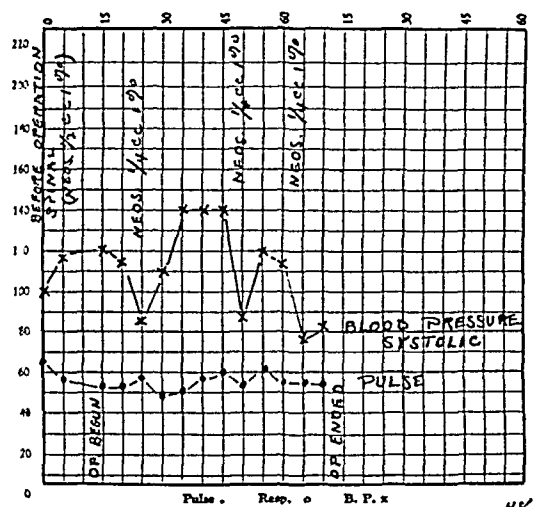


FIG. 2. Demonstrating the maintenance of blood pressure above the preoperative level during perineal resection of the rectum. Pontocain, 15 mg.; neocain, 75 mg.

during the operation than the average normal blood pressure preoperatively. In only ten cases was the neosynephrin repeated during the operation. For readministration,  $\frac{1}{4}$  c.c. of the 1 per cent solution was given. It was repeated once in seven cases, twice in two cases, and three times in one case.

The pulse was slower in 56 per cent of the cases during operation than the average preoperatively. However, we feel that if we had attempted to maintain the blood pressure at a higher level by more frequent injections of neosynephrin, the bradycardia would have been more evident, since we noted that the bradycardia occurred as the blood pressure rose and tended to disappear as it fell. Tachycardia definitely did not occur. The average pulse rate was 79.

SERIES OF FIFTY CASES OF SPINAL ANESTHESIA USING NEOSYNEPHRIN TO MAINTAIN BLOOD PRESSURE

Average preoperative blood pressure	126
Average blood pressure during operation	125
Average preoperative pulse	81
Average pulse during operation	79

The bradycardia has been explained in various ways. Lorthan and Oliverio<sup>4</sup> state that it is a compensatory reaction following

the increased stroke volume of the heart. It may also be a compensatory slowing due to stimulation of depressor fibers from the

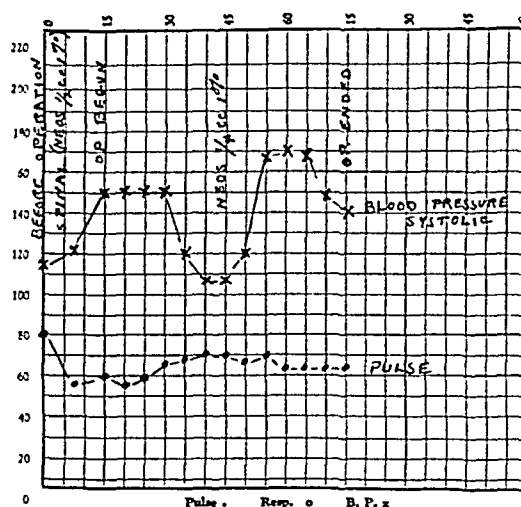


FIG. 3. Showing repeated response to neosynephrin and bradycardia. During excision of upper portion of sigmoid and colostomy. Pontocain, 15 mg.; neocain, 75 mg.

carotid sinus and the aortic arch. Brunner and de Takats<sup>5</sup> show an electrocardiogram of a patient whose heart rate dropped from 58 to 40 following neosynephrin; simple bradycardia is evident.

We feel that the compensatory mechanisms are not strong enough to produce such a marked lowering of the heart rate over a prolonged period. Also, a case is cited in which the bradycardia outlasted the rise in blood pressure by two hours. From our own observations we are inclined to believe that neosynephrin has a direct depressing action on the heart, perhaps similar to the action of quinidine. If this is so, then the rate of impulse formation in the sino-auricular node would be slowed and a simple bradycardia would result.<sup>8</sup> More work will have to be done before the etiology of the bradycardia can be explained. The action of neosynephrin on the refractory period and the conductivity in the bundle of His should throw some light on the subject.

In the matter of central nervous system stimulation, we noticed no untoward effects. None of the patients complained of feeling anxious or nervous during or after the operation. Our preoperative medica-

tions may have masked these symptoms if they were present, but it may be noted that none complained of palpitation, throbbing

turned to the ward his blood pressure dropped to 112 and then rose steadily until three hours after operation, when it was

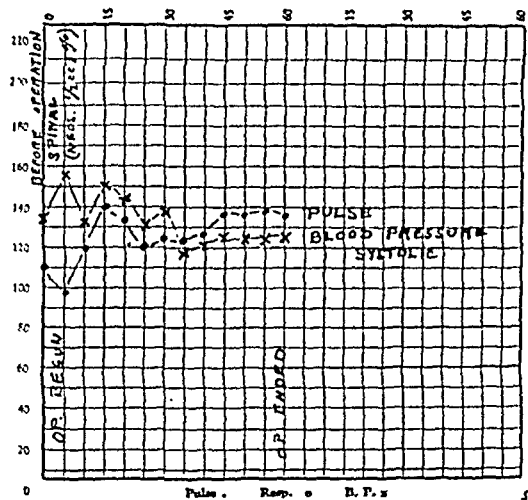


FIG. 4. Demonstrating stability of blood pressure with a heavy and high spinal. Pontocain, 12 mg.; neocain, 100 mg.

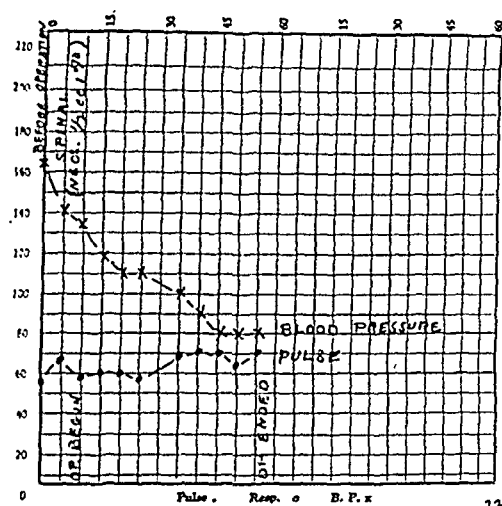


FIG. 5. Showing inability of neosynephrin to raise blood pressure in presence of toxic shock.

of the head or other symptoms produced by closely allied drugs, such as epinephrine or ephedrine.

Figure 2 demonstrates the rise in blood pressure and the bradycardia. Neosynephrin hydrochloride was repeated three times, each dose being  $\frac{1}{4}$  c.c. of the 1 per cent solution. Each time a definite rise of blood pressure occurred, although the pulse remained fairly stable at the lowered rate achieved after the initial injection. In this patient a perineal resection of the rectum was performed under spinal anesthesia of 75 mg. of neocaine and 15 mg. of pontocaine.

In Figure 3 the blood pressure and pulse are shown during an operation for excision of a carcinoma of the sigmoid with colostomy. The patient was a 67 year old male considered only a fair operative risk. The level of anesthesia was above the costal margin. The anesthetic consisted of 15 mg. of pontocaine and 75 mg. of neocaine in 4 c.c. of spinal fluid. The average blood pressure during the entire operation was higher than the preoperative pressure, although the neosynephrin was repeated only once. The bradycardia is also well demonstrated in this case. After this patient re-

back to the original preoperative level. The pulse rate remained at 56 until two hours postoperative at which time it began to rise.

Figure 4 shows the course of a patient who had a cystostomy performed for the removal of bladder calculi. Only the initial injection of neosynephrin hydrochloride was given. The average blood pressure during the operation was lower than the original preoperative pressure by only three points. The maintenance and stability of the blood pressure is striking, in view of the fact that the patient received 100 mg. of neocaine and 12 mg. of pontocaine. Bradycardia was exhibited in this case only after the original dose of neosynephrin. As soon as the blood pressure began to drop the pulse rose and remained high.

Neosynephrin, as shown by Johnson, will not raise the blood pressure in cases where there is loss of blood volume by hemorrhage or where a peritonitis exists. The latter condition he terms a type of toxic shock. He shows that the pressor effect is lacking when the fluid volume is low. It might appear from this that the action of neosynephrin would be an excellent indicator of

pletely, so that the fluid level is flush with the margin of the incision. The alcohol is allowed to remain in situ for a few minutes and then is siphoned off by a suction apparatus.

If the contents of the abdominal cavity are particularly foul and there is a large quantity of serofibrinous exudate, alcohol is alternately poured into the abdominal cavity and siphoned away until the return flow is clear. Apprehension over using this method should be negligible for there is little or no danger from the introduction of too much alcohol, and even when large quantities are used, no untoward results are to be expected. After the free alcohol has been siphoned out, abdominal protective packs are so arranged that the entire area involved in the inflammatory appendiceal reaction is isolated as completely as possible, from the remainder of the abdominal cavity.

The appendix is then sought and is removed, since it is the focus of infection. Some surgeons lean to the conservative idea that in cases of peritonitis accompanying appendicitis, the appendix should be allowed to remain until a more favorable time for removal. This idea which at one time was universal is now generally discarded so that the majority of surgeons now believe that a ruptured appendix should be removed immediately, although some still hold that, in a small percentage of cases, conservative treatment and delay in operation offer the patient the best chance of recovery. If, the peritonitis is the result of a perforated viscus or other cause, rather than of an inflamed appendix, the cause of the peritonitis is sought and eliminated.

During the course of the operation, the involved areas of the abdominal cavity exposed in the incision, are repeatedly flushed with alcohol, but no excessive quantity of alcohol is permitted to remain for more than a few minutes in the peritoneal cavity. In less than five minutes from the time it has been poured into the cavity, all excess alcohol is removed by siphonage.

We regard free drainage as a corollary and an essential measure in the treatment of suppurative peritonitis. It is always employed through a widely open portal, and accessory drainage is provided, if necessary, through additional openings in the abdominal wall. One is usually made through the lateral abdominal wall into the kidney fossa. Gravity drainage has been found beneficial. In some instances we have placed the patient in a ventral or right lateral position in order to facilitate dependent drainage.

During the course of our work, we have made the following observations:

1. Cultures taken from the fluid exuding from the incision when the abdominal cavity was opened in some cases was found to be free of organisms. In the same patient a culture taken from the wound discharge one or two days later usually showed *B. coli*. Negative cultures we think may be due to the fact that the specimen is taken from the supernatant fluid which extends beyond the active margin of the peritonitis and, as a rule, is sterile.

2. Drainage in every instance was thought to be beneficial. In cases where intra-abdominal alcohol lavage had been used, there was almost complete cessation of discharge from the drainage openings for the first few days. Following this restriction period there was a gradual return of drainage usually containing *B. coli* and of a foul odor.

3. If, on dressing the wound, we find the discharges from the wound infected with *B. coli*, it is our custom to instill pure cultures of lactic acid *B.* or acidophilus bacilli into the infected cavity. In a few days, the quantity of the discharge is greatly reduced, it becomes more fluid and acquires the sour odor of lactic acid. The colon bacilli when present rapidly disappear, but streptococci or the staphylococci, when present, apparently are not affected. These are subsequently destroyed by the local instillation of 70 per cent ethyl alcohol.

4. We have determined that alcohol can be absorbed from the peritoneal cavity. In



a few patients the absorption is so great that a mild degree of intoxication is induced. It is surprising to observe the happy and undisturbed state of mind of many alcohol lavaged patients, operated on under spinal anesthesia. This carefree attitude remained an enigma to us until chemical examination of the blood twenty minutes to three hours after alcohol lavage showed 10 to as high as 52 mg. of alcohol per 100 c.c. This amount was found after twenty minutes and, as a rule, decreased after two hours, increasing again at the three hour interval. We came to the conclusion that the primary increase was most probably due to a rapid immediate absorption of alcohol through the serosa of the peritoneum; the decrease which followed the primary increase we thought was due to an increased elimination which temporarily overbalanced the absorption of alcohol. The absorption during the second hour period, we thought, was slowed by a decreased peritoneal absorption due to the paralyzing effect of the alcohol on the vessels of the serosa, as well as to the precipitation of a fibrinous albuminous deposit on the surface of the serosa. As this fibrinous material was dissolved, increased absorption again occurred, with consequent increase in the alcohol content of the blood. This hypothetical explanation may not be correct, and in some instances the quantities of alcohol in the blood did not correspond to the above formulations.

5. Where alcohol was used the usual complications of suppurative peritonitis, such as gastromesenteric ileus, paralytic ileus, tympany, persistent vomiting and hiccoughing, seldom occurred.

6. The beneficial effect of alcohol, we believe, is the result of the following factors:

(a) Its action as a bactericide on the infecting causative organism or organisms. This was particularly noted in peritonitis due to *B. coli* and streptococci.

(b) Reduction of the activity of bacterial organisms which survived the initial contact with the lavaging alcohol. There was a minimum of discharge from the wound or

none at all for a few days after operation, a period which may coincide with that required for a new and more resistant generation of bacterial organisms to develop.

(c) Increase of resistance in this latent period, of all the tissues, and particularly those in the localized areas of infection, against the offending bacteria, to such a degree that in the contest of opposing forces the bacteria are destroyed.

(d) During this interval of latent activity, it may be assumed that there is decreased absorption of toxins and poisonous tissue products from the infected areas in the abdominal cavity. The alcohol has coagulated the albuminous content of the exudate which is spread as a nonpermeable fibrinous layer on the surface of the peritoneum.

(e) At the same time a hyperemia is induced in the surface layers of the peritoneum, constituting an added protection to the underlying tissues. In some instances, the hyperemic reaction of the peritoneum is so great that small petechial hemorrhages are seen under the serosal layer.

(f) It has been suggested that inhibition of absorption of toxic products from the abdominal cavity may be the result of an exosmosis which the alcohol may cause. The restriction of immediate postoperative absorption from the abdominal cavity is indicated by the increased absorption of alcohol in the third hour after intra-abdominal instillation. The beneficial systemic effect of the counter action of toxic products in the circulation, is indicated by a rapid reduction in the pulse rate and drop in temperature.

(g) The variable amount of alcohol absorbed into the blood in different individuals may act as a mild blood antiseptic and be a source of energy for the destruction of foreign proteins and other toxic substances. With this object in view we have advocated, and have used with satisfying results, the intravenous introduction of alcohol in the treatment of severe hemolytic streptococcus septicemia. In some

cases the intravenous injection of alcohol in proper dilution (25 per cent in salt solution) has been used as a supportive measure in acute suppurative peritonitis.

(h) In extremely weak patients, alcohol, injected intravenously properly diluted with saline solution, not only has antiseptic value, but may also be of nutrient value because of its high caloric content. In fact, because of the ease by which it is oxidized, alcohol may be more advantageous than glucose.

In reviewing hospital records for mortality statistics in generalized diffuse peritonitis following appendicitis, certain diagnostic criteria must be observed. It is important that the diagnosis be correct. We based the diagnosis of acute spreading peritonitis principally upon local symptoms and the general symptoms of peritonitis as usually defined.

In one case the sudden acute pain in the right side or umbilical region was followed by vomiting, which gradually subsided, the pain veering from the center of the abdomen to the lower right quadrant. The leucocyte and polymorphonuclear counts were high. The pain became worse and suddenly increased markedly. Vomiting recurred and shortly after this secondary exacerbation the abdomen was found very tense with release pressure tenderness marked. The leucocyte count was very high, the polymorphonuclear count usually increased and the patient appeared to be very sick. The pulse was rapid and soon became thready. The vomitus gradually changed until it finally consisted of a foul material of bad odor. Deep pressure tenderness on the abdominal wall caused the patient to assume a characteristic defensive position. He put his hand lightly on the abdomen and held the other raised to ward off any possible contact with the abdomen. This sudden defense reaction is instantly brought into play if a motion is made to touch the abdominal wall.

We regarded the diagnosis of acute diffuse peritonitis as confirmed if, when the abdomen was opened, there was free turbid

fluid in the abdominal cavity, with positive bacterial flora. The omentum was usually tucked high up in the abdomen or was free without any definite limiting adhesive attachment. In other words, no attempt or very slight attempt had been made by the omentum to wall off the extension of the inflammatory process in the appendiceal area. In a few cases where an appendiceal abscess had been present and had suddenly perforated into the peritoneal cavity, a very fulminating type of peritonitis was found.

The results obtained by the use of alcohol have been computed by one of us (Wm. R.) from the records of all patients suffering from localized peritonitis and generalized peritonitis resulting from appendicitis in St. Joseph's Hospital. Forty-three cases of localized and forty-nine cases of generalized suppurative peritonitis (total ninety-two) were studied. Forty-six cases were treated by 70 per cent alcoholic lavage of the abdominal cavity; the remaining forty-six cases (handled by other members of the surgical staff) were treated in the usual manner by wide incision of the abdominal wall and removal, if possible, of the diseased appendix. If this was not regarded as advantageous, the appendix was allowed to remain and was removed at a later operation. The postoperative treatment in these cases was not markedly different from that used in the alcohol lavaged cases, except that in our personally treated cases we carried out frequent blood transfusions, gave large quantities of glucose intravenously, and make generous use of vascular stimulants and shock preventatives.

Acute suppurative appendicitis, localized appendiceal abscess, and generalized suppurative peritonitis were more prevalent in the age period of 10 to 40 years. The maximum number occurred in the period between 10 and 30 years. This definitely establishes, in our series, that serious appendicitis is a disease of youth and young adult life. The great number in this period may be due to neglect, since many, failed to see a physician early. This neglect appar-

ently was the result of economic stringency and the necessity of carrying on their daily work to earn a living. Appendicitis has more complications and seems to be more severe and fatal in the young adult.

TABLE 1

General- ized Diffuse Peritonitis	Num- ber of Cases	Deaths		Causes of Death
		No.	Per Cent	
1920-1933	46	2	4.3	1. Was moribund on entrance 2. A generalized peritonitis was induced postoperatively by ill advised and too forcible removal of gauze packs
1931-1939	23	2	8.7	1. Pneumonia (autopsy) 2. Postoperative shock (moribund)

	Alcohol Treated	Non-alcohol Treated
Time in hospital	22.04 days	27.59 days
Highest postoperative pulse rate	112	127
Time elapsed before normal temperature	9.1 days (1933-1939)	12.48 days (1933-1939)
	9.5 days (1920-1933)	13.35 days (1920-1933)
Mortality	23 cases (1933-1939)	26 cases (1933-1939)
	2 deaths (8.69 per cent)	12 deaths (45.39 per cent)
	46 cases (1920-1933)	44 cases (1920-1933)
	2 deaths (4.3 per cent)	22 deaths (50 per cent)
	Total—69 cases 4 deaths (5.79 per cent)	

Males were more frequently affected than females in the ratio of 59 to 33.

Of the ninety-two cases of peritonitis (localized and general) forty-three, or 47 per cent, had localized peritonitis and forty-nine, or 53 per cent, had generalized peritonitis.

The average delay in this series of cases was one to twenty-two days, with the average time of operation about 4.23 days (101.52 hours) after the onset of the acute symptoms. The average period of delay before operation, in patients in whom alcohol lavage was used was 4.77 days (112.8 hours); in the patients in whom alcohol was not used, the average period between the onset of symptoms and operation was 3.69 days (93.6 hours).

Patients treated with intra-abdominal alcohol lavage recovered more quickly than did those in whom alcohol was not used. In the alcohol treated group the temperature dropped to normal an average of 9.1 days after operation, with the shortest period three days and the longest forty days (the latter in a case complicated by postoperative intestinal obstruction). The average of 9.1 days may be compared with an average of 12.48 days in cases not treated by alcohol. The shortest time in which the temperature returned to normal in this series of cases was three days, the longest time was fifty-nine days. The average difference was 3.38 days. This is an important factor, since the earlier drop in temperature enhances the comfort and well-being of the patient, permits earlier recovery and more prompt discharge from the hospital. The pulse rate rose postoperatively, in the alcohol treated cases, to an average of 112; it was 127 in the other series. This may indicate that patients treated with alcohol did not remain so toxic. The pulse rate was obviously not measurably accelerated by the use of alcohol.

The average time of hospitalization was markedly less in the patients who were treated with alcohol, 22.04 days on the average, as compared to 27.59 days for those treated without alcohol, a difference of 5.5 days. The average length of hospitalization in the combined series of cases was 23.83 days.

Abdominal cultures were taken in sixty-nine of the ninety-two cases (75 per cent). Single organism cultures were positive in fifty-four, or 75 per cent. Thirty-two of the

fifty-four positives were from Dr. Behan's service; twenty-two were pure cultures of a single type of organism, twenty-one Gram-negative bacilli and one Gram-positive diplococci. Of the remaining twenty-two positive cultures, eleven were single organism cultures, ten pure Gram-negative bacilli and one a staphylococcus. Of the thirty-three single organism cultures, 61 per cent of the total positive cultures, thirty-one (57 per cent) were pure cultures of Gram-negative bacilli. Twenty-one of the remaining positive cultures contained two or more of the following organisms: streptococcus, staphylococcus, Gram-positive and negative bacilli, Gram-positive diplococci.

In the last series of forty-nine cases of generalized peritonitis in St. Joseph's Hospital, twenty-three were treated with intra-abdominal alcohol lavage. Two deaths occurred, a mortality rate of 8.69 per cent. One of these deaths occurred on the seventh day postoperatively and was due to pneumonia. Autopsy showed a typical left lower lobe lobular pneumonia (type 2). The abdomen was free of fluid, and only a small quantity of fibrin was present in the area from which the appendix had been removed. The second death was that of a small boy who had been sick for five days before entering the hospital. At the time of entrance, the abdomen was enormously distended. After removal of the appendix it was very difficult to reintroduce the intestine into the abdominal cavity. This was accomplished only after intestinal aspiration and the introduction of a catheter into the lumen of the bowel. We feel that this case was not properly treated and that the trauma and injury to the intestines caused the shock which, in spite of all our efforts, terminated the child's life twelve hours later.

In this period from 1920 to 1931 we had forty-two cases of generalized suppurative peritonitis resulting from appendicitis in which treatment with alcohol was given. Only two deaths occurred in this series, making four fatalities in sixty-five cases of

generalized suppurative peritonitis or a mortality of 6.15 per cent since 1920. Of twenty-six similar cases in the same hospital not treated with alcohol, twelve died, a mortality rate of 45.39 per cent.

Reed and associates reported a rate of 33.9 per cent in this type of case; Hawk and Woodhouse had a 60 per cent mortality. King reports eighteen deaths (15.5 per cent) in 116 cases of all types of peritonitis complicating appendicitis and 52.9 per cent in diffuse spreading peritonitis. Ruddel, Sicks and Loomis had a mortality in diffuse peritonitis of 30 per cent. LeGrand Guerry treated 123 cases of spreading peritonitis by deferred operation, with two deaths, a mortality of 1.6 per cent. At the same time eighty-five cases of diffuse peritonitis in immediate operation was done showed seven deaths, or a mortality of 8.2 per cent. In 1932, ninety-three cases of diffuse peritonitis were operated on immediately, with ten deaths, a 10.7 per cent mortality, while 128 cases of diffuse peritonitis treated by deferred operation showed two deaths, or a mortality of 1.5 per cent. Hamilton Bailey also reported a very low mortality (1.6 per cent) in the deferred operation cases. Sworn and Fitzgibbon (1939) from the St. Thomas Hospital, London, report a 19 per cent mortality in 231 cases of ruptured appendicitis with peritonitis. Reed and his associates (1936) had 33.9 per cent mortality in ruptured appendicitis with generalized peritonitis. We had no fatalities in perforated appendicitis with localized peritonitis, as compared to a 6.30 per cent mortality reported by Hawk and Woodhouse.

We found that the death rate was higher in males than in the females. This is in accordance with the frequency of the occurrence of the disease; although acute suppurative appendicitis was found to be more frequent in females.

Patients in the decade between 20 and 30 years of age suffered the smallest number of deaths. The greatest proportional mortality occurred in the 50-60 year period; this, according to our statistics, was found to be the most dangerous decade of

all, with the exception of the extreme old age groups.

#### CONCLUSIONS

1. Acute appendicitis is definitely a disease of the young, especially those in the third and fourth decades.

2. Males are more frequently affected by serious acute appendicitis than are females.

3. There usually is a dangerous delay, which in our series averaged about 101 hours, from the time of the onset of the symptoms of acute appendicitis until operation.

4. In 33 per cent of the general peritonitis cases laxatives had been given prior to operation. These were the most serious cases. Bowers found that a laxative given to patients with appendicitis complicated by peritonitis reduced the chances of recovery to one in seven.

5. In suppurative peritoneal involvement, the abdominal cavity is lavaged with 70 per cent alcohol at the time of operation, and the temperature falls to normal in about 9.1 days as compared to 12.48 days when alcohol is not used.

6. Alcohol lavage has no noticeable effect upon the pulse rate.

7. The use of alcohol lavage cuts down the length of hospitalization markedly (5.5 days).

8. The death rate in the series of generalized peritonitis treated with alcohol was 8.69 as compared to 45.39 per cent in the cases not treated with alcohol. We had no deaths in our cases of localized peritonitis. The deaths in the generalized peritonitis were not due to the peritonitis but to complications.

9. The prognosis is much better in patients in whom the culture from the intra-abdominal exudate shows a pure strain of organism than it is in those in whom such culture shows the presence of more than one organism.

10. The mortality rate was higher among males than among females.

11. The lowest group mortality occurred in the age group 20 to 30 years and the greatest in the sixth decade.

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# CASE REPORTS

## SUBACUTE OBSTRUCTION OF THE RECTOSIGMOID BY ADHESIONS\*

### A METHOD OF PREVENTING ITS RECURRENCE

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IT is so unusual to have obstruction of the rectosigmoid from peritoneal adhesions alone in an individual over 50, that one must in such obstruction act with a definite suspicion of malignancy. It is, however, unnecessary, once malignancy is definitely ruled out, for the patient to continue with a permanent colostomy if some method of straightening out the rectum can be devised. In the following case a procedure for accomplishing this and reestablishing continuity of the bowel is described.

M. M., a single white woman of 58, was first admitted to the Mt. Vernon Hospital on December 30, 1935. She had had general abdominal cramps with distention for two weeks and intermittent vomiting during this period. She had always been constipated, but this constipation had been increasing in the preceding few weeks. She had lost 30 pounds and had been generally feeling poorly in the last year.

She was pale and undernourished, and her abdomen was considerably distended and tympanitic without masses or tenderness. Rectal examination showed an indefinite mass at the tip of the examining finger on the left. White blood count was 28,600 with 78 per cent polymorphonuclear leucocytes. Barium enema showed an almost complete obstruction near the rectosigmoid junction with what appeared to be a filling defect and narrowing of the bowel, but the barium passed on up into the colon through this obstructed area.

It was felt that the patient had a carcinoma of the rectosigmoid with subacute intestinal

obstruction. She was given a transfusion, and on January 6, 1936, the abdomen was explored through a lower midline incision. The intestines, especially the colon down to the rectum, were markedly distended, and there was considerable free hemorrhagic fluid in the peritoneal cavity. Because of the distention it was impossible to explore the pelvis well, but it was felt that there was possibly a mass in the left pelvis. A loop colostomy was done through a left pararectus stab wound.

Following operation there was a fairly smooth course, and the colostomy functioned well. Irrigations of the lower segment were attempted, but it was found that while it was possible to irrigate the rectum from below upward, this could not be done from above downward. Proctoscopy was done, and an obstruction of the rectum at 6 inches was found, but there was no tumor visible.

On February 26, 1936, a second operation was done and no tumor was found, but it was discovered that the rectosigmoid was bound down in the pouch of Douglas so that the rectum and sigmoid made a complete S, with the upper loop directly over the lower. It was felt at this time that this was the cause of the obstruction through a ball-valve action. The adhesions were freed, a Mikulicz clamp applied to the colostomy spur, and a biopsy of the perirectal tissue taken. This showed a non-specific granuloma.

The patient's postoperative course was quite smooth, but no fluid could be passed from above the rectum downward. Another proctoscopic examination showed the same condition

\* From the Surgical Service of the Mt. Vernon Hospital. Read before the Section on Surgery, New York Academy of Medicine, January 6, 1939.

as the first. The patient was discharged home in good general condition with a well-functioning colostomy.

point of obstruction could be felt through the rectal wall at the tip of the finger. The barium was removed, and then barium was introduced



FIG. 1. December 31, 1935. Previous to first operation. Barium enema. Partial obstruction to the flow of barium at the junction of the rectum and sigmoid with the suggestion of a tumor in this location.

The patient knew that she did not have a cancer, and since her colostomy was troublesome, she was anxious to have it closed, if possible. Proctoscopy was done both through the rectum and through the colostomy, and in both cases the proctoscope came up against rectal wall as it looped upon itself. During a period of a month or so several fecal impactions occurred in the rectum and had to be removed digitally, causing considerable distress. This, of course, proved that there was some fecal material getting through the obstructed area. Barium x-rays of the rectosigmoid segment were taken with the barium passed through the colostomy. There was delay, but without definite obstruction in the lower sigmoid and a complete obstruction just above the rectal ampulla and to the left of the midline, beyond which the barium could not be forced. This

through the rectum and found to flow without delay through the obstruction up the sigmoid and out the colostomy. These findings confirmed the idea of an S-shaped loop of lower sigmoid and upper rectum adherent in the pelvis with a ball-valve type of obstruction.

Operation was done on July 23, 1936, through another lower midline incision. The condition was verified. The lower sigmoid and upper rectum were firmly bound down in this S-shaped manner to the posterior aspect of both tubes and ovaries and the uterus. As far as could be made out these organs were normal. The adhesions did not give the impression of being the result of a previous salpingitis with pelvic peritonitis, although this was possibly the etiology. There were no diverticula in the sigmoid, and there was no tumor. The adhesions were separated and the peritoneum in

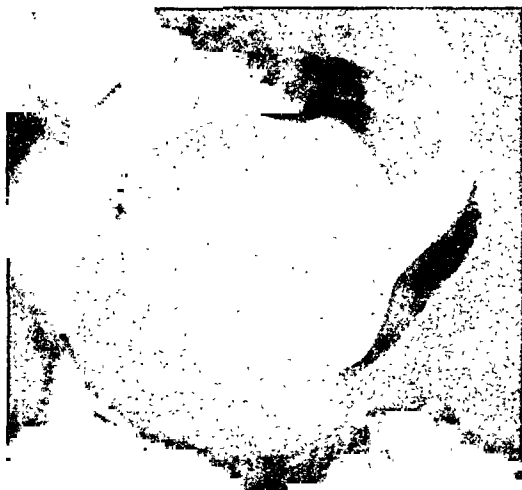


FIG. 2. July 16, 1936. Previous to third operation. Barium through tube in colostomy. There is a tube in the rectum also. Apparently complete obstruction in the rectum to the downward flow of barium.



FIG. 3. July 21, 1936. Previous to third operation. Barium enema. There is delay to the flow of barium in the upper rectum. The barium did, however, slowly flow into the sigmoid and out through the colostomy.

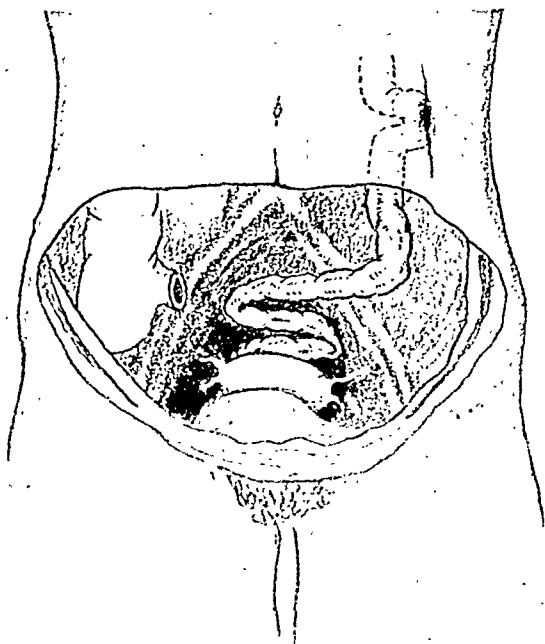


FIG. 4. Diagram of pathology found at third operation. There is an s-shaped loop of rectosigmoid bound down in the cul-de-sac by adhesions. This caused a ball-valve type of obstruction with almost complete interference to passage from above downward but only moderate from below upward.

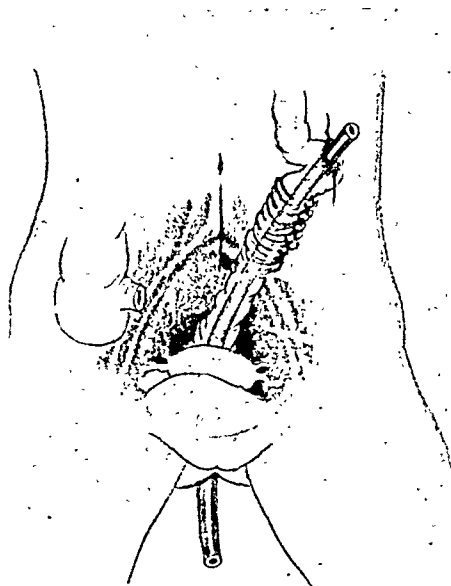


FIG. 5. Diagram of procedure at third operation. The adhesions have been broken up and the rectosigmoid straightened out. A large rubber tube has been inserted from the rectum upward and out the colostomy, and the sigmoid has been pleated up into the left lower quadrant with sutures.



the depth of the cul-de-sac opened. A hand was then placed down into the hollow of the sacrum as far as the coccyx, and by thorough

The patient had a smooth, uneventful convalescence. The hard rubber tube was removed on the seventh postoperative day. Following



FIG. 6. Barium enema two years after last operation (closure of colostomy). There is no obstruction, and except for a somewhat redundant loop of rectosigmoid the bowel is quite straight. A small remaining spur at the site of the closed colostomy is evident.

dissection it was possible to straighten out the sigmoid and rectum completely. Several attempts were made by an assistant to pass a half-inch rubber tube through the colostomy down into the rectum and several more to pass it from the rectum up. A final attempt through the rectum was successful, and the two ends of the tube were brought out through the colostomy and rectum respectively. The sigmoid was then pleated up along the tube and the pleated portion sutured to the lateral peritoneum in the left lower abdominal quadrant. Two large rubber dam drains were placed down alongside the rectum on each side of it and brought out in the lower angle of the wound. With the abdomen still open a Mikulicz clamp was applied by an assistant to the colostomy spur and guided from inside the abdomen, since no true spur had been constructed.

its removal it was found that it was easily possible to pass water through the rectal segment from above downward as well as from below upward. There was practically no drainage from the wound, and the drains were removed on the eighth day. The patient was discharged in good general condition.

It was found that the spur had not been well cut down, and, consequently, Ochsner clamps were applied to it on two successive occasions, August 16 and October 11, under evipal anesthesia. Each time that these clamps were applied the patient had a great deal of pain with vomiting and distention for a day or so, but her subsequent course showed no evidence of injury to any other loop of intestine. The considerable time that was left between applications of clamps was necessary because of the marked edema of the spur which devel-

oped each time. During this time catheters were readily passed through the rectosigmoid segment from above and below, and it was kept well open, although the patient's bowels did not move by rectum even after the last time that the clamps were applied.

On December 3, 1936, an extraperitoneal subfascial closure of the colostomy was done after applying two large Ochsner clamps to the depth of the spur in V fashion, cutting out the intervening tissue with the actual cautery, and then removing the clamps.

Following operation the patient became markedly distended and had abdominal cramps with nausea and vomiting. On the night of the third postoperative day she suddenly passed a large amount of gas by rectum and was

immediately relieved. Cramps and distention bothered her slightly until the seventh day, but from then on her bowels moved normally by rectum with mineral oil and milk of magnesia. Moderate infection developed in the wound, and there was slight fecal drainage for a few days only. She was discharged from the hospital on the seventeenth postoperative day with her abdominal wound practically healed.

In the two years since the last operation, the patient remained perfectly well. She gained 35 pounds in weight, and her bowels moved normally by rectum with the help of small amounts of mineral oil and milk of magnesia. All the abdominal wounds healed well and in spite of some weakness in the thrice-opened lower midline incision, there is no actual hernia.



THERE may be some tenderness along the veins in acute or subacute phlebitis. One may find more or less tenderness along the arteries in periarteritis nodosa.

From—"Peripheral Vascular Diseases" by Kramer (Blakiston).

# VOLVULUS OF THE STOMACH

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**V**OLVULUS is a rather unusual type of displacement of the stomach wall.

Congenital anomalies of the stomach are rare, hypertrophic pyloric stenosis in infancy being the most frequent abnormality. Diaphragmatic hernia ranges next in occurrence. Partial or complete situs inversus seldom gives rise to complaints. The stomach may be incarcerated in an abdominal hernia, or more often, a small portion may be occluded within an epigastric hernia, causing great pain. Intussusception following gastroenterostomy and consisting of telescoping of the jejunal stoma into the stomach has also been reported. Recently phrenicotomies have been thought to lead to displacement and functional derangement of the upper portion of the stomach, a view promulgated especially by French authors. A lengthening of the mesentery seems to be the causative agent in such cases.

Volvulus is a twist of an organ around an axis. It represents a rotation brought on chiefly by extrinsic factors. Congenital elongation of the ligamentary apparatus of the stomach is essential in producing this type of displacement. Another prerequisite appears to be a short based pedicle around which rotation may take place. Various factors which favor such twisting and rotating movements include a change of intraluminal pressure.<sup>9</sup> Any increase of the latter accentuates motility, and in stomachs with a sufficient amplitude of peristaltic play, it may cause angulation and kinking. Such torsion may finally culminate in an actual twisting of the whole viscus.<sup>7</sup>

Cases of volvulus of the stomach are quite rare, about seventy-five having been reported in all.

The picture in acute volvulus consists of marked distention, vomiting, peripheral

collapse, and other signs of high intestinal obstruction. The diagnosis is often difficult, and may be confused with ruptured viscus, acute pancreatitis, a cardiac catastrophe, or mesenteric thrombosis.<sup>2,7,14</sup> Preceding gastric symptoms are lacking, although ptosis is usually present. Many authors believe that a concomitant lesion, especially ulcer of the stomach, is the factor responsible. An example of this is the hour-glass stomach, when the distal portion "gives away" and undergoes a complete rotation. More often, however, adhesions to the pancreas or penetrations into the adjoining organs may furnish the anchorage around which the rotation takes place.<sup>3,6,9,11</sup>

The volvulus may be total or partial. Total volvulus represents a rotation around an axis of 180 degrees, so that the greater curvature is approximated to the diaphragm, and the posterior wall is facing the anterior abdominal wall. The twisting takes place usually from right to left around a vertical axis. (Figs. 1 and 2.) A rolling from the anterior to the posterior aspects occurs around a transverse axis, a less frequent type of rotation. (Figs. 3 and 4.) The adjoining organs, especially the spleen and the transverse colon, are frequently involved.

A traction on the esophagus may obliterate the cardiac orifice, and no stomach tube can be passed. Due to the kinking of the lesser curvature, two isolated sacs, the cardiac and the pyloric portions of the stomach are found. The right colon may become displaced because of a twisting and shortening of its mesentery. A contracted mesocolon produces a derangement in the colonic passage in the right half. This may render reduction very hazardous at times.<sup>9</sup>

Acute volvulus is a surgical problem. The onset is sudden, with pains, vomiting, inability to swallow and marked distention,

with peripheral collapse. Unless surgery is instituted, the outcome is always fatal. In partial volvulus the findings are less char-

sions may be found, including gastric ulcers with penetration, hour-glass contraction, and severe perigastritis. Internal herniae,

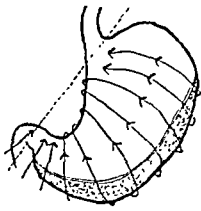


FIG. 1.

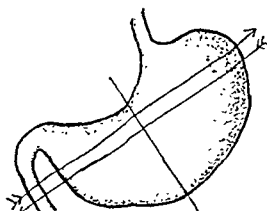


FIG. 2.

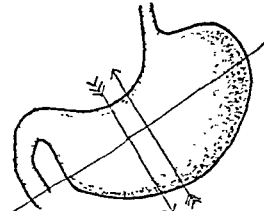


FIG. 3.

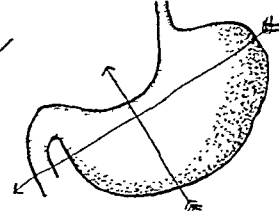


FIG. 4.

FIG. 1. Axis of rotation of lesser curvature in volvulus of the stomach. (After Thorek.)

FIG. 2. Rotation around the transverse axis. (After Kocher.)

FIG. 3. Rotation around the longitudinal axis. (After Kocher.)

FIG. 4. Rotation around the transverse and long axis as in case reported.

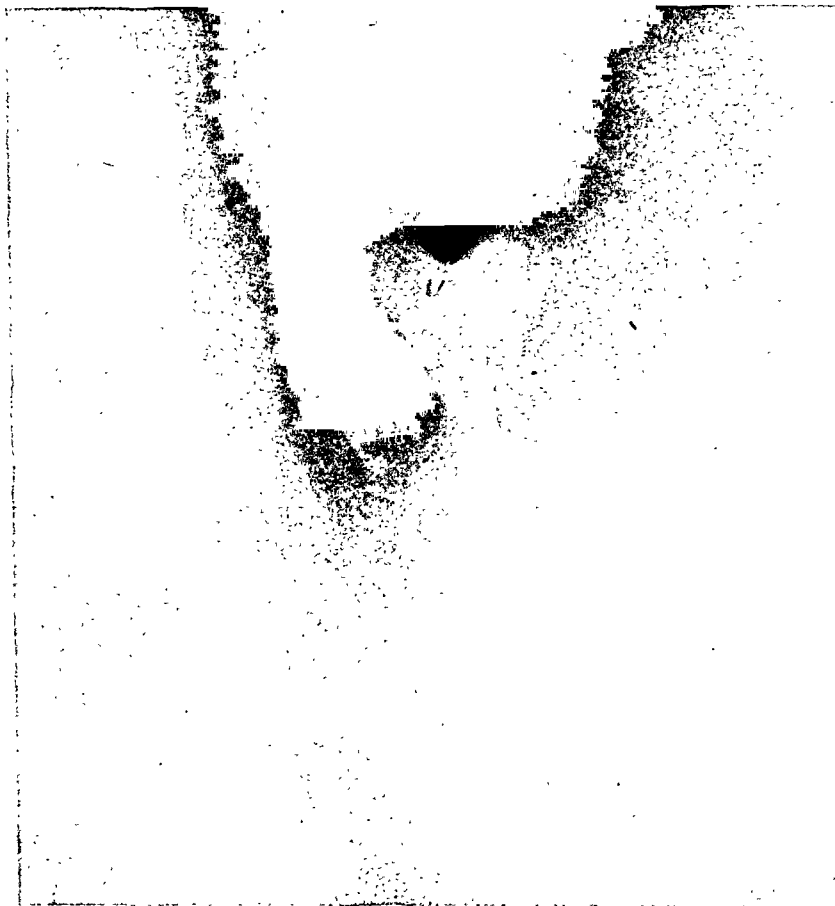


FIG. 5. X-ray shows a "tipped over" stomach. Cardia at the level of the pylorus. Large penetrating ulcer, u, on the lesser curvature. The greater curvature is situated above the lesser curvature, and is approximated to the anterior abdominal wall.

acteristic. Long-standing digestive disturbances, vague in character, may obscure the underlying pathology. Usually, there is ptosis, with accompanying laxity of the mesenteric attachment. Other gastric le-

due especially to congenital slits in the mesocolon, and duodenum mobile range next in frequency. The exciting cause is the vigorous peristalsis most commonly produced by overfilling of the stomach.

Diagnosis is difficult, and only x-ray examination enables one to evaluate the confusing pathology. Treatment in the acute total volvulus presenting high intestinal obstruction is surgical, consisting of reduction of the volvulus and gastropexy in order to prevent recurrences. The reduction is not complete until the coronary vessels are in their normal anatomic relation. Mortality is about 60 per cent. In the partial, intermittent type of volvulus, medical management often suffices if no coexistent lesion is noted. Whenever intrinsic gastric pathology complicates the picture, gastroenterostomy is necessary.

#### CASE REPORT

A. F., 70 year old female, reported in September, 1938, stomach complaints of ten years' duration. Pains had occurred two hours following meals and at night and were relieved by food and alkali. X-ray examination in 1928 disclosed ulceration of the stomach that responded well to medical management. A few years later, she suffered recurrences and periodical exacerbations. She did not lose any appreciable amount of weight, but had stabbing pains in the epigastrium, associated with nausea.

Stomach analysis showed the presence of free HCl with hypoacid readings.

The x-ray examination was highly illuminating. *The cardia occupied the level of the pylorus.* The air chamber was also in this unusually low position. The lesser curvature was situated above the greater curvature, and the cardia had become approximated to the pylorus. At about the midportion of the lesser curvature, a smooth-walled crater the size of an English walnut was seen. (Fig. 5.) The outlines of the remaining portions of the stomach were normal. The colon, gall-bladder, etc., failed to reveal signs of organic pathology.

This observation, confusing at first, led one to believe that the stomach had rotated almost 180 degrees around its imaginary transverse axis.

A diagnosis of chronic volvulus of the stomach with penetrating ulcer on the lesser curvature was made. The patient received the customary medical management without relief. She suffered a great deal of pain, necessitating opiates, and, about six weeks later, vomited

a copious amount of blood. Several transfusions were necessary to restore her blood volume. In view of the fact that a repeated hemorrhage was threatened, (poor quality of pulse, arteriosclerotic, friable blood vessels) and that her severe gastric pains persisted, laparotomy seemed advisable.

A rotated stomach with an exceptionally long mesenteric attachment was found. The cardia occupied the level of the pylorus, pulling the distal portion of the esophagus downward. There was a penetrating ulcer at about the midportion of the lesser curvature with dense adhesions to the pancreas. It evidently served as the fulcrum around which the stomach performed its unusual excursion and rotation. Because of the contracted and shortened mesocolon, an anterior antecolic short-circuiting gastroenteroanastomosis was done. The postoperative course was uneventful, and the patient has been relieved of practically all her digestive complaints.

#### SUMMARY

Chronic volvulus of the stomach is of rare occurrence. Factors inducing this lesion are chiefly, visceroptosis, abnormally long mesenteric attachment, and other congenital malformations of the suspensory apparatus. The acute type of chronic volvulus needs immediate surgical interference consisting of a reduction and pexy. The chronic type is often intermittent, reversible, and at times, may be approached medically. However, if a concomitant lesion is found responsible, surgery is necessary.

A case of chronic volvulus of the stomach is presented. A huge penetrating ulcer on the lesser curvature with subsequent complications necessitated surgical interference. An anterior antecolic gastroenterostomy was successfully performed.

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THE symptoms of duodenitis (or "ulcer duodenitis") are very similar to those of duodenal ulcer; and many patients suffering from it are operated on in the belief that they are suffering from duodenal ulcer. However, on the basis of this "ulcer duodenitis" a definite duodenal ulcer may subsequently develop.

From—"Surgery of the Alimentary Tract" by Devine (Williams & Wilkins).

# DIVERTICULITIS OF THE CECUM

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**M**ULTIPLE diverticulitis of the left side of the large bowel is a more or less common condition. According to a report published by W. J. Mayo<sup>1</sup> in 1930, it occurred in 5.7 per cent of 31,838 colon examinations carried out in the Mayo Clinic from 1924 to 1930. Thirty per cent of these cases had the disease in its recognized clinical form.

Diverticulitis of the right side of the large bowel is a rare disease, and most unusual when confined to the cecum alone. Cases of solitary diverticulitis of the cecum have been reported, but a survey of the literature by Bennett-Jones<sup>2</sup> in 1937 revealed only seventeen such cases. He reports three new cases.

Nowhere in the available literature was there an account of diverticulitis of the cecum associated with diverticulosis of the right half of the colon, so the occurrence of five such cases at The Clinic in the past ten years was felt of such interest as to justify reporting. Three of these cases were seen in the last year.

There are two types of diverticula, the true and the false. True diverticula are abnormal pouches that have their walls made up of the same structures as the organ involved. This type is best illustrated by Meckel's diverticulum. Most diverticula of the large bowel are of the false variety—that is, one or more layers of the normal bowel wall are absent. Many authorities claim that only the Meckel's diverticulum is a true congenital diverticulum, while all others are false or acquired. Leonardo,<sup>3</sup> however, in 1930 reported a solitary diverticulum of the cecum that had circular muscle fibers present in part of its wall. With reference to the large bowel alone and to the cecum in particular, we may safely state that the great majority of the

diverticula present are of the false or acquired variety. These are further divided into the primary and secondary types. The primary type is thought to be very rare, as pointed out by Bennett-Jones. The secondary types are also unusual, but as noted by Greensfelder and Hiller,<sup>4</sup> may not be so rare as previously supposed.

The etiology of these secondary diverticula is well known. They arise as a result of some operative procedure in the right lower quadrant. The etiology of the primary type is still quite obscure. The epiploic appendages, the piercing of the bowel wall by blood vessels, loss of fat and changes in intra-abdominal tension may play a part, but, as pointed out by Greensfelder and Hiller, do not satisfactorily explain all cases. They offer another possible etiologic factor, the retention of some residual form of the appendix. Leonardo's case would tend to support this theory. The fact remains that the diverticula are simply outpouchings or herniations in the wall of the bowel, and their presence is due to the failure of that portion of the wall to retain its normal contour.

The diagnosis of diverticulitis of the cecum is usually made at the time of operation. Except for a slightly milder and more prolonged course in the case of diverticulitis it cannot be differentiated from appendicitis. There is less tendency towards vomiting, but the laboratory and physical findings are the same. As pointed out by Cooke<sup>5</sup> it is just another of the conditions with which a surgeon must be able to cope after he has made the diagnosis of appendicitis.

The treatment of diverticulitis of the cecum varies according to the condition found at operation. Several of the cases reported have required resection of the diverticulum. Others were so extensive as to

require resection of the cecum. In several of the articles published, Stewart's<sup>6</sup> in particular, attention was brought to the low mortality rate—all cases having recovered. When the associated high mortality of surgery of the large bowel is considered, and several of the cases required resection, perhaps the favorable outcome was due to the skill of the surgeon rather than to the benignity of the lesion. There is, however, a wealth of evidence to prove that an inflammatory diverticulum per se is not a dangerous condition. Their course as a rule is to subside without perforation or other complications. Bennett-Jones is of the opinion that failure to recognize the condition leads to more radical surgical procedures than the disease requires.

No case in this series required extensive surgical procedures. In one case the diagnosis was tentatively made without exploration. The appendix had been previously removed. After the acute stages were over the diagnosis was confirmed by a colon enema. In two cases the findings were such that it was impossible to differentiate peri-appendicitis from true appendicitis. In the other two cases the appendix appeared normal. The appendix was removed in all instances.

#### CASE REPORTS

CASE I. Mrs. F. G., white, age 30, was first seen on November 2, 1928 complaining of pain in the right lower quadrant, associated with nausea and vomiting for the previous twelve hours. The temperature was 99.2°F., white cells 9,000, polys. 82 per cent. The urine was negative. There was localized tenderness with marked rigidity over McBurney's point. Pelvic examination was negative. A diagnosis of acute appendicitis was made, and an immediate operation performed.

Through a low right rectus incision the appendix was inspected and looked normal. There was an intense inflammatory reaction about a cecal epiploica opposite the appendix. When this was opened a gangrenous diverticulum was seen. It was removed and the hole in the cecum repaired. The appendix was removed. Convalescence was uneventful.

A barium colon study ten years later revealed two diverticula on the medial wall of the cecum, and one at the hepatic flexure of the colon.

CASE II. Mrs. K. I., Japanese, age 60, was seen on September 12, 1935 complaining of pain in the mid-lower abdomen for twenty-four hours; the pain had finally shifted to the right lower quadrant. Slight nausea was present. Temperature was 99°F. There was exquisite tenderness in the McBurney area with rigidity. Pelvic examination was negative. No history of previous similar attacks was elicited. White cells numbered 11,000, polys. 72 per cent. There was no history of urinary disturbance, although the urine examination revealed 2 plus albumin with an occasional cast and red cell. The diagnosis of acute appendicitis was made.

Through a low right rectus incision the appendix was explored. It appeared grossly negative. Opposite the appendix on the lateral border of the cecum was an inflammatory mass the size of a hen's egg. One small diverticulum was seen, and with gentle dissection of the inflammatory mass another appeared, acutely inflamed and containing a fecal concretion. This diverticulum was removed and the opening into the cecum repaired. The appendix was removed and two rubber tissue drains inserted through a stab wound in the McBurney area. Convalescence was very stormy. Two weeks after the primary operation a second operation for intestinal obstruction was necessary. This revealed obstruction at the ileocecal junction as a result of inflammatory reaction. An enterostomy with 24 F. catheter was made. Following this the patient slowly recovered, aided by several transfusions, and was discharged on November 21, 1935, seven weeks later.

After the second operation there was considerable wound infection and a fecal fistula formed. However, this healed during the eighth week of illness. She has had no symptoms referable to the abdomen except a dragging sensation due to an incisional hernia that was relieved by an elastic girdle. No barium study of the colon has been made.

CASE III. Mr. C. C., Chinese, age 22, was first seen on January 29, 1938 complaining of pain in the right lower quadrant for the previous thirty-six hours, with anorexia but no vomiting. There was no history of previous similar attacks. The temperature was 101°F.,



white cells 18,000, polys. 78 per cent, with a slight shift to the left. The urine was negative. Physical examination revealed exquisite tenderness over McBurney's point with the suggestion of a mass. A diagnosis of acute appendicitis was made.

A McBurney incision revealed an acutely inflamed appendix. Opposite the appendix on the lateral wall of the cecum was an indurated inflammatory mass, the size of a lemon, with a soft spot in the center. Palpating through the opposite wall of the cecum it was felt that this soft spot was a hole in the lateral wall of the cecum. It was believed that adequate evacuation of the diverticulum had occurred into the lumen of the bowel and further exploration was unsafe. The appendix was to gross appearances acutely inflamed and was therefore removed. Two rubber tissue drains were placed lateral to the cecum and brought out through the wound. Convalescence was uneventful. The drains were gradually removed. A barium enema three weeks later revealed a diverticulum of the medial wall of the cecum, but none was seen at the site of the inflammatory mass or in any other portion of the colon. The tissue report on the appendix removed was "negative except for marked periappendicitis."

CASE IV. Mr. S. N., Japanese, age 38, was seen on July 17, 1938 complaining of pain in the right lower quadrant for forty-eight hours, with, however, no nausea, vomiting, or distention. His temperature was 99.2°F., white cells 12,800, polys. 80 per cent. The urine was negative. There was exquisite tenderness over an old McBurney scar. The appendix had been removed eight years previously, the history at that time having been typical of acute appendicitis. The surgeon who had removed the appendix was a capable one. We felt that we were dealing with a diverticulitis and the patient was admitted to The Queen's Hospital and given expectant treatment. A series of blood counts and his clinical course showed the infectious process to be improving.

A barium enema on the second hospital day revealed a small diverticulum on the medial wall of the cecum. No others could be seen in the rest of the large bowel. The patient was discharged symptom-free after five days' observation. No positive physical findings remained.

CASE V. Mrs. S. M., Portuguese, age 42, was first seen on January 5, 1939. She had had

pain in the epigastrium for thirty-six hours, and it had gradually shifted to the right lower quadrant. Nausea and vomiting had been present for nine hours, and the pain had become very severe in the last four hours. Her temperature was 100.6°F., white cells 13,500, polys. 85 per cent. The urine was negative. The abdomen was extremely tender just above and to the right of McBurney's point with marked rigidity. A diagnosis of acute appendicitis was made.

Through a lower right rectus incision the appendix was located. It was thick, indurated, but not acutely inflamed. There were two small diverticula on the medial side of the cecum. On the lateral wall of the cecum, opposite the appendix, there was an indurated inflammatory mass the size of a lemon. No areas of softness or localized masses were palpable. The appendix presented easily and was removed. Two rubber tissue drains were placed lateral to the cecum, adjacent to the mass, and brought out through a generous stab wound in the McBurney area.

The pathologic report on the appendix did not show any primary acute inflammatory process. Convalescence was uneventful.

X-ray study revealed the diverticulum seen at operation and also one at the hepatic flexure.

#### DISCUSSION

The history, clinical course and treatment of five cases of diverticulitis of the cecum have been briefly presented. The inflammatory process in each was not extensive. The operative procedures were conservative. Perhaps just criticism can be made as to relying on drains to take care of possible rupture through the serosa of the bowel. However, it was felt in two of the instances to be less dangerous than searching for and tying off the diverticulum itself. In all five cases other diverticula were seen at operation or their presence was discovered later. In two cases other diverticula than the one inflamed were recognized at the time of operation. In one the presence of multiple lesions was proved only at later x-ray examination. In none of the previously reported cases is there a report as to whether this search was carried out. It is only logical to assume that any patient

having a diverticulum in any portion of the colon might have more. Certainly the search should be made to rule out the multiplicity of lesions. In one case (Case II) there was no follow-up barium enema. In four cases the pre-operative diagnosis of appendicitis was made, and the fifth case was typical of appendicitis.

#### SUMMARY

The study of these five cases and the review of the available literature give insufficient data to form definite conclusions, but certain salient features are emphasized.

1. Diverticulitis of the cecum clinically cannot be differentiated from appendicitis and must be considered when dealing with any pathologic process about the cecum.

2. The etiology is still obscure.

3. The treatment must vary according to the condition encountered, but it should

be remembered that the tendency of diverticulitis is to subside spontaneously.

4. The disease is probably not so rare as previously supposed.

5. It is suggested that cases of apparent solitary diverticulitis of the cecum may be accompanied by adjacent non-inflamed diverticula, and that a careful barium study be made to rule out this condition.

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# ADENOCARCINOMA OF THE JEJUNUM, TREATED BY ENTEROENTEROSTOMY AND COMPLICATED BY INTUSSUSCEPTION\*

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**W** C., a white male, aged 68, was admitted to the Cumberland Hospital on February 10, 1938, with a history and a side-to-side anastomosis short-circuiting the constricted portion was performed. There was a marked improvement within the

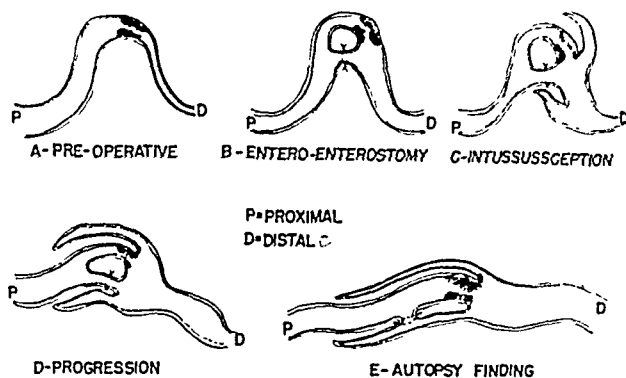


FIG. 1. Diagrammatic sketch indicating the probable pathogenesis for the intussusception. The shaded areas represent the neoplasm partly occluding the lumen of the jejunum. Note that the tumor and the entero-enterostomy suture line are in the inner loop of the intussusception in the diagram representing the findings at autopsy.

of loss of 20 pounds in weight in the previous four months, and abdominal pain, vomiting and constipation increasing in severity and frequency in the previous ten days. The past and family history were irrelevant.

Examination showed cachexia. The temperature was 101.6, pulse 106, respirations 26, and blood pressure 118/64. Heart and lungs were negative. The abdomen was soft and distended. There was visible peristalsis in the right half of the abdomen. No masses were felt.

Blood study showed a moderate polynucleosis and an increased urea nitrogen content (34 mg.). Gastric analysis was normal. A flat plate of the abdomen showed distention of the intestine.

The patient was observed until February 11, 1938, when, under local anesthesia, an exploratory laparotomy was performed through a mid-line incision. A hard annular constriction of the jejunum producing intestinal obstruction was discovered. A diagnosis of carcinoma of the jejunum was made, and, because of the poor condition of the patient, resection was deferred

first forty-eight hours postoperatively. Later there was a complicating parotitis from which the patient recovered. He did exceptionally well, seemingly convalescing uneventfully, when he suddenly went into shock on the twelfth postoperative day, and expired.

*Necropsy.* The abdomen showed a clean laparotomy wound. The left inguinal region bulged and contained gas communicating with that in the peritoneal cavity. The peritoneal cavity contained about 2,000 c.c. of purulent fluid and foul-smelling gas. All surfaces of the intestine were covered by fibrin and were adherent to each other. The heart weighed 460 Gm. The lungs showed bronchiectasia, pleural thickening, multiple areas of caseation and calcification (apical).

About 1.2 meters from the duodenojejunal junction a large mass consisting of intussuscepted jejunum was encountered. After the outer layer was opened, the mucosa presented itself in the shape of a tube 30 cm. in length, the lumen of the distal end of which was markedly constricted by an annular, fungating,

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partly necrotic, and ulcerated adenocarcinomatous mass. Ten cm. proximal to the mass there was a slit-like stoma of the recent anastomosis, communicating with the internal

that from the Mayo Clinic, comprising twenty-one cases up to 1939. A review of the literature to date fails to reveal any case similar to that described above.



FIG. 2. Low power magnification of the inner loop of intussuscepted jejunum at the site of the neoplasm, showing ulcerative and papillary character of the adenocarcinoma, which marks the site of reduplication of the proximal, P, and distal, D, portions of jejunal wall. The serosa, S, is covered by fibrinopurulent exudate.

cylinder of gut. At one end of the stoma there was a perforation of the wall (8 mm. in diameter) communicating with the peritoneal cavity.

The liver showed fat replacement and a mild degree of cirrhosis. The kidneys had arteriosclerotic changes and extratubular calcium deposition. The right kidney was hydronephrotic, the prostate hypertrophied.

*Anatomic Diagnosis:* (1) Carcinoma of jejunum. (2) Jejunojejunostomy wound. (3) Intussusception of jejunum. (4) Perforation of jejunum (operative site). (5) Generalized peritonitis. (6) Benign hypertrophy of prostate. (7) Right hydronephrosis. (8) Renal arteriosclerosis and calcinosis. (9) Apical pulmonary tuberculosis (healed). (10) Nodular calcification of pleura. (11) Bronchiectasis. (12) Pleural adhesions, fibrous. (13) Cardiac hypertrophy. (14) Fat replacement of liver. (15) Visceral congestion and cloudy swelling.

#### DISCUSSION

Carcinoma of the jejunum is rarely encountered, the largest series reported being

The probably pathogenesis of the intussusception and the anatomic relations of the tumor and enteroenterostomy are given in the accompanying diagram. (Fig. 1.) Obstruction was produced by the tumor, and relieved by the subsequent short-circuiting enteroanastomosis. The latter was sufficiently near the neoplasm to be involved in the intussusception.

#### CONCLUSIONS

1. A thorough review of the literature reveals the infrequency of carcinoma of the jejunum.

2. A case of this condition is here reported which was treated by enteroanastomosis, followed by perforation, generalized peritonitis, and preterminal intussusception.

We wish to express our thanks to Dr. S. H. Polayes, Pathologist of the Cumberland Hospital, for his assistance in the preparation of this report.

# SQUAMOUS CELL EPITHELIOMA OF THE VULVA\*

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THIS surgical problem in squamous cell epithelioma of the vulva has been well covered by the German writers, but very little attention has been given to this subject in the United States. There is very little in American literature until about 1915. Most of the articles are case reports or reviews of the cases reported in the literature, and many of the case reports are not authentic because there was no biopsy, no surgical pathologic report, and no follow-up record.

Morgagni was the first to write on the subject in 1751, when he reported a case. Mayer, in 1888, reported eight cases from the literature. In 1905, Dittrick reported a study of 135 cases, seventy-five of them studied microscopically. In 1908, Teller incompletely reported thirty-five cases. In 1912, Rothchild reported 331 cases of malignant growths of the vulvae. In 1929, Rentschler of the Mayo Clinic reported seventy-one cases from their records of twenty years. This is a complete and detailed study of the case histories, biopsy, surgical pathology, and follow-up records, either by the clinic, doctor or relatives. Taussig reported 112 cases in thirty-five years, and between 1915 and 1930 reviewed forty-five cases.

Carcinoma of the vulva, compared with other malignant lesions of the female, is quite rare, according to Virchow, representing only 1.35 per cent. Other writers report as follows: Guilt, 1.48; Taussig, 1.20; Mayo Clinic series, 1.25 per cent. Schreiner and Wehr reviewed 118 cases of carcinoma of the vulva in 11,737 malignant lesions. Of these, 108 were in married women, and ten in unmarried women. In 29,000 gynecologic admissions to Johns Hopkins, there were twenty-seven cases of epithelioma of

the vulva. Stout reported that there was not a single case in the Presbyterian Hospital in New York City in ten years.

The lesion usually occurs in advanced years, but cases have been reported in most every decade of life, most frequently in the fifth, sixth, and seventh. Like all other epitheliomas, it may vary in degree of malignancy and rapidity of growth and metastasis. The most common pathologic type is squamous cell carcinoma.

*Etiology.* There are many causes that can be ascribed to as being contributory in character in the etiology of this disease. The ones most frequent are: pruritus, chronic irritation, chronic infection, and leucoplakia. Pruritus of long standing can produce excoriation, abrasions, and pigmentation of the skin which in turn could be an indirect cause. Frank, Rothchild, and the Johns Hopkins authorities consider it the most frequent forerunner. In these series pruritus was present in more than 50 per cent of the cases. Persistent and obstinate pruritus is often a forerunner of trophic changes in all parts of the body. In 1887 Bex wrote on leucoplakia as a cause of malignant changes in the vulva. Taussig considers leucoplakia the most important factor and advises cautery excision for leucoplakic lesions.

The lesion may begin as a simple induration of the dermis, then a small papule develops, which usually breaks down into a small vesicle. It may resolve itself into a hard nodule. Later there may be a fissure and then the lesion develops into one of two types, either a hard nodular or an ulcerative growth. If it is of the ulcerative type, the neoplasm may occur soon after the original induration. The ulcer is usually irregular and raw in appearance.

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*Signs and Symptoms.* The change may be present for some time before the patient notices it and before any symptoms arise.

After pruritus, the next important symptom is pain. Pain, as in all other malignant lesions is manifested late, or not until ulceration has occurred. It may be burning, stinging, piercing, or lancinating, and often is very sharp. It may be located at the site of the lesion, or can be referred to the hip or the thigh. It is usually aggravated at night or by walking, and in a short time renders the patients bedridden.

In all cases reported, the patients did not seek medical attention until late in the course of the disease, after ulceration has taken place and bleeding has occurred. By this time many cases are hopeless for surgical intervention.

Urinary disturbances may be an early symptom. Incontinence, however, occurs as a late symptom, especially if the tumor is periurethral. After the lesion has existed for some months, secondary symptoms such as secondary anemia, cachexia, lassitude, loss in weight, loss in appetite, loss in strength, and a general physical debility occur.

*Metastasis.* Metastases are very important as regards the surgical intervention and the prognosis. Blood supply and lymph drainage of the vulva and vagina are abundant, so that metastases occur early and cause the prognosis to be poor. Metastases occur in the inguinal, femoral, pubic, and iliosacral chains. Several cases of metastases to the perineum and gluteal regions have been reported. The inguinal and femoral nodes may or may not be enlarged. If the lymph nodes are palpable, hyperplasia or malignancy is to blame. The lymph nodes are involved in from one to two-thirds of the cases. In Schreiner and Wehr's series of cases the lymph nodes were involved in 62 per cent of the cases and the spread was by direct continuity. In the Taussig series, the lymph nodes were involved in 60 per cent of the cases.

However, the nodes may not be palpable and may yet contain cancer cells, and it is

for this reason that radical surgery must be done. Crossen recommends resection of all lymph nodes on both sides, both superficial and deep. Metastasis have been found in the liver, brain, vertebra, lungs, pelvis, and descending ramus of the pubis, etc.

*Diagnosis.* The patients rarely present themselves early for diagnosis. In the Mayo Clinic series, the time from onset to examination was 1.49 years. This lapse of time accounts for the fact that so many cases are hopeless at the time of examination.

Primary vulvar carcinoma must be differentiated from secondary metastases due to primary lesions in the ovaries, fundus, cervix, or breast. If the primary lesion is in a stage of ulceration, it must be differentiated from chancre, chancroid, condylomata, leucoplakia, and chronic infected Bartholin's glands.

Chancre is differentiated by the brownish color and the definite regularity and circular arrangement. The ulceration is usually more rapid and more painful.

Chancroid has very little resemblance to the ulceration of malignancy. In chancroid the evolution is much more rapid with a larger amount of secretion.

Condylomata have been mistaken for malignancy, but they very seldom, if ever, ulcerate and usually are not painful.

In leucoplakia, the growth is usually slow and there is very seldom any inguinal or femoral adenopathy. Some authors state that as high as 50 per cent of cases of leucoplakia are forerunners of malignant changes. Taussig subscribes to this theory.

A chronic infected Bartholin gland may produce a cystic tumor resembling malignancy.

The Wassermann reaction is a very definite aid in diagnosis and differential diagnosis. If lues is present, it makes the prognosis more unfavorable. In Schreiner's series, syphilis occurred eleven times and these patients all died within a year after the diagnosis was made. Biopsy and microscopic study of tissue are essentials.

*Treatment.* The type of treatment varies and many factors must be taken into con-

sideration: (1) grade of malignancy; (2) age of patient; (3) the extent of the lesion and metastases; (4) associated lesions; (5) the patient's general physical condition. Surgeons differ regarding the advisability of dissection of the lymph nodes. Rupp believes that both the superficial and deep lymph nodes should be resected as in a carcinoma of the breast. Crossen states that the lymph nodes on both sides, both superficial and deep should be resected regardless of adenopathy. Döderlein, in 1907, stated that if such a procedure was carried out, the postoperative results would be much better.

Basset gave the first description of the superficial and deep inguinal and femoral lymph chains. He advised a two stage operation, first the excision of the inguinal and femoral lymph chains, and two weeks later excision of the tumor mass.

Some authors use the knife, some the cautery, some both knife and cautery. The present day radical method would consist of knife and cautery of the growth, inguinal and femoral lymph nodes, superficial and deep on both sides, to be followed by x-ray or radium or both. If recurrence should show up at a later date, they must be treated in the same manner as the original lesion, by cautery and x-ray. In Rothchild's series of 225 cases, 111 were operated on without excision of the lymph nodes, and there was a recurrence in seventy-one cases or 63.96 per cent—which is entirely too high. Taussig states that in his series the Bassett operation gave 81 per cent of five year cures while other types of operations gave only a 30 per cent result. These consisted of cautery to the growth, simple vulvectomy, and resection of the superficial lymph nodes.

Taush, in the Tubinger Clinic, reported forty-seven cases in which only fifteen had x-ray and radium. Out of this number, only one patient lived three years or more.

**Prognosis.** The prognosis depends on many factors. If patients come early, the physician is able to handle such lesions with radical resection of the growth, superficial

and deep inguinal and femoral nodes on both sides, followed by x-ray and radium. One can then hope for indefinite prolongation of a useful life. In most series, the larger percentage of the patients was dead at the end of three years, most of them at the end of the first year. This can be accounted for by the delay in consulting a doctor, incomplete and incompetent surgery, and the abundant blood and lymph supply producing early metastasis. In forty-four of the seventy-one cases in the Mayo Clinic series<sup>13</sup> the time from examination to death was 2.12 years. Thirteen patients were alive and free from recurrence, and their average length of life from the time of examination to the date of the report was 7.77 years.

Welch and Nathanson report 135 patients. Of this number, 25 per cent were dead in seventeen months, 50 per cent were dead in thirty months, and 75 per cent were dead in sixty-five months.

In Schreiner and Wehr's report, 18 per cent of the patients lived five years. If there was no metastasis and only the local growth had to be excised, 42 per cent lived five years. If metastases are present, five year survivals are unusual.

#### CASE HISTORY

G. K., 38, a housewife, the wife of a baker, reported on July 12, 1928 a tumor mass in the vagina of nine months' duration.

Her father was 73, living and well. Her mother had died at 46 from cancer of the breast. Three brothers and two sisters were living and well.

The patient had begun to menstruate at 13, and the periods occurred regularly at twenty-eight day intervals, lasting four to five days. There had been no pregnancies. Right salphingo-oöphorectomy and appendectomy had been done in 1922.

About nine months before the patient had noticed a small hard mass in the vagina, but paid no attention to it. It gradually increased in size, and about six months before began to discharge; three months before, it began to bleed. At first, the discharge was watery with no odor, but later there was a foul odor and intermittent streaks of blood were noted. For

four to six months the mass had been painful at intervals, especially when much walking was done.

The patient weighed 160 pounds. Her blood pressure was  $125/80$ , her pulse rate 76, temperature 99.

Numerous lymph nodes were palpable in the left inguinal region. A large mass involved the left labium majus and minus. It was about the size of an orange, with an ulcerated center covered by a grayish-white, foul discharge. The mass extended toward the midline at the symphysis. It was painful on palpation and bled easily. No involvement of the right side was noted. Bimanual examination revealed the uterus to be one and one-half times normal size, but there was no tenderness and no tumor masses were palpable in the adnexa. Leucorrhea, grade 2, was present and two small hard nodules could be seen on the upper lip of the cervix.

Biopsy confirmed the clinical diagnosis of labial carcinoma. Sections showed broad masses and infiltration of columns of atypical epithelial cells. In the superficial portions the cells had a squamous appearance, being fairly uniform in size, shape, and staining. An occasional epithelial pearl was seen, but in the deeper portions the cells were less differentiated, polyhedral and spindle-shaped, varying in size. Some nuclei were hyperchromatic and a few mitotic figures were seen. The stroma was scant in amount, composed of a cellular fibrous tissue heavily infiltrated with round and plasma cells and a few polymorphonuclear leucocytes. The growth was a squamous cell carcinoma.

The urine was cloudy and acid, with a specific gravity of 1.024, a trace of albumin, no sugar or diacetic acid. Much pus and a few bacteria were present. Hemoglobin was 75 per cent; red blood cells 4,210,000; white blood cells 10,949, with lymphocytes 27 per cent, and polymorphonuclear cells 73 per cent. The blood Wassermann was four plus.

The patient was given 0.6 neosalvarsan intravenously for five days.

July 21, 1928, under ether anesthesia, a radical excision of the growth and the left lateral wall of the vagina was done, using the Percy cautery. The resection was extended to the inner side of the thigh and to the spine of the pubis. The wound was left wide open, three curved forceps were left in place, and packing was inserted to stop superficial bleeding.

The pathologic specimen showed several large pieces of fat fibrous tissue and tumor tissue removed with the cautery. The largest measured  $4\frac{1}{2}$  by  $3\frac{1}{2}$  inches, and the smallest  $1\frac{1}{2}$  inches in diameter. Sections showed a squamous cell carcinoma with only moderate differentiation with pearl formation and many mitoses. Another section showed fibrous tissue with areas of round cell infiltration, and groups of glands resembling Bartholin's.

The patient had a splendid convalescence and was dismissed on July 29. On the fourteenth day postoperative, there was a secondary hemorrhage which was controlled by packing. On November 4, 1928, the patient entered the Methodist Hospital and on the following day, under ether and nitrous oxide anesthesia, by knife and cautery, a wide dissection of the inguinal, femoral and public lymph nodes was done. The cautery was applied to a small granulating area at the site of the original operation. Three Penroes drains were left in place.

The several masses of fibrofatty tissue contained many large and small soft, cellular glands. Sections from one of these glands showed masses of enormous cells, irregular in size and shape, many having hyperchromatic nuclei and mitotic figures. Areas of round cell infiltration were seen in scant stroma.

The patient was dismissed from the hospital November 25.

Between May 7 and May 17, 1929, a total of 600 r. was given anteriorly and posteriorly to the pelvis. On October 3, 1929, a flat radium pack was made and placed against the cervix and held in place with gauze which also pushed away the bladder and rectum; 100 mg. of radium was used and filtered through 1 mm. of lead and 2 mm. of rubber and backed by 2 mm. of lead. This was left in place for twenty-six hours for a total of 2,600 mg. hours of radium. On January 2, 1931, 1,440 mg. hours of radium was applied to the cervix. On November 31, 1931, there was no evidence of malignancy in the cervix, vagina, femoral or inguinal lymph regions.

On July 1, 1937, the patient returned for a check-up examination, and reported that she was working in the alteration department of a large department store. She was feeling well. The general examination was essentially negative except for a slight edema of the left thigh and leg. There was no evidence of



recurrence of the growth in the vagina, cervix, uterus or on the opposite side.

### SUMMARY

1. A case of squamous cell epithelioma of the vulva is reported.

2. The most frequent symptoms of this type of cancer are pruritus, pain, bleeding, discharge, and the secondary symptoms of cachexia.

3. Right and left sides are almost equally involved in all the series reported.

4. The treatment should consist of excision of the growth with the cautery, and dissection of the femoral, inguinal and pubic lymph nodes, both superficial and deep with knife and cautery.

5. X-ray and radium should be given as adjuncts in the postoperative treatment, never as the sole treatment unless the case is inoperable or secondary metastasis makes surgical intervention inadvisable.

6. If early surgery is carried out, an indefinite prolongation of life can be expected, but a cure cannot. These patients should be under frequent examinations in order to observe any early metastasis.

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# LIPOMATA OF THE UTERUS\*

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LIPOMA of the uterus as a pure lipoma is of extreme rarity. Even mixed tumors containing fatty elements, while occurring more often than the pure lipomas, are by no means frequent. When the number of lipomas in all the fatty structures of the body and the perhaps greater frequency of tumors of the uterus is considered, the rare occurrence of true lipoma in the uterus is striking. The reason seems to lie in the very limited amount of fatty tissue in the uterine structure where it appears only in extremely small amount about the blood vessels. The clinical importance of lipoma is not of the greatest moment but the number of reported cases is so small that each case may add to the bulk of our knowledge and its study may help the solution of the problem of the cause and pathogenesis of tumor growth.

The uterus has long been recognized as a frequent site of the development of neoplasms. Ellis, 1906, mentions the study of 13,824 patients of both sexes treated in four large London hospitals because of primary new growths. Of these patients 9,227 were women, and 28.7 per cent, or 2,649, suffered from tumor of the uterus. Ellis in the same report states that Gurlt, in 13,971 tumors analyzed at Vienna Hospital, found 4,115, or 29 per cent, to be uterine in location. No mention is made of a lipoma in the series of Williams, which may be considered as fairly representative. A total of 2,649 cases were recorded: cancer 1,571; myoma 883; nonmyomatous polyps 191; sarcoma 2; cystoma 2. Nor, in fact, does Ellis leave one to conclude that Gurlt's report shows such a case. Seydel (quoted by Ellis) found only four cases of true lipoma of the uterus reported up to 1903, and only one of the four compared in size and location with the

specimen reported by Ellis. He states that two of Seydel's cases were tiny cervical polyps and the third was a subserous growth the size of a cherrystone. There were, in addition to these four cases of lipoma, two of lipomyoma and four of lipofibromyoma on record. Still one other case in Lebert's Atlas is designated simply as adipose tissue. Seydel accepts only these eleven cases as authentic lipomatous tumors of the uterus, rejecting three cases cited by Knox because they were not examined microscopically. However, at least two of these latter cases appear from their gross description to have been lipomas or lipofibromas. From the reason given, Seydel appears justified in excluding them from his list.

Ellis gives the list of Seydel's cases and states that he has verified all but two which he made no attempt to trace.

1. The theory that they result from a fatty degeneration of the fibrous or muscular tissue in fibromyoma of the uterus. In support of this it has been urged that fatty degeneration has been observed in the muscle cells and the connective tissue of these fatty tumors, and one author believed that he could trace the process in its various stages from beginning fatty degeneration to completed fat cell. This idea is contrary to the present ideas of the specificity of tissue growth. Moreover, some of the tumors have shown no fatty degeneration, whatsoever, in the connective or muscular tissue.

2. The theory that the fat cells arise by multiplication of fat cells congenitally misplaced.

3. The view that the fat cells arise by multiplication of the fat cells brought into the uterus along with the blood vessels.

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Ewing mentions a case of polypoid lipoma observed by Orth, also two cases of intramural uterine lipomas reported by



FIG 1 Photograph of opened uterus, posterior view. The fatty tumor of the fundus protrudes from the sectioned surface. The cornua are elongated. The mucosa is hemorrhagic and papillary.

Merkel, while lipomatous areas of mixed tumors of the uterus are mentioned by Gerlach. Pollack thought his intrauterine lipoma originated from a portion of omentum protruding into a wound of the uterus.

Lund reported to the New England Surgical Society in 1933 an unusual case of uterine lipoma complicated by gallstones.

Arthur A. Humphrey and Russell L. Mustard report a fatty growth about the size and shape of a large cherry accompanying and adjacent to, but separated from, an ulcerated carcinoma of the cervix. About an inch above the ulcerated cervix the yellow fatty intramuscular mass protruded through the surrounding myometrium. Sections through the yellow tissue showed a typical adipose tissue structure which appeared quite sharply demarcated from the myometrium. According to the authors, several points of interest present for consideration in this case, first because of a

fifteen year cure of a breast carcinoma with auxillary involvement, and second because it may in a measure explain the genesis of lipoma as well as acanthoma in this site.

Ewing states that a variable histogenesis may occur in adenocanthoma of the cervix but that those in the uterus may be on the basis of metaplasia in almost all instances and do not require heteroplasia of squamous cells. While transition from adenomatous tissue to squamous celled structure has been long recognized and is frequently seen in the cecum and elsewhere, the idea that a similar metaplasia changes epithelial structure into lipomatous tissue is somewhat remote. It appears more likely that a single heterotopic focus may have carried all of these tissue structures.

#### CASE REPORT

Mrs. L. T., 63, a white widow, was admitted to the hospital January 18, 1939.

She was the mother of five living children. Her menopause at 45 had been uneventful. She had no unusual discharge until one week before examination, when a moderate amount of vaginal bleeding suddenly appeared and continued for two days, followed by spotting for five days. Mild cramp-like lower abdominal pains accompanied the bleeding.

The patient was well developed, weighing 159 pounds. Her blood pressure was 190/88, the Wassermann negative and the urine negative. Hemoglobin was 84 per cent; color index .9; erythrocytes numbered 4,490,000; leucocytes 9,600; polynuclear neutrophils 70 per cent; lymphocytes 28 per cent; monocytes 2 per cent.

A moderately enlarged but smooth cervix was noted at the vaginal introitus. There was a second degree procidentia with a slight blood tinged discharge from the os, but on introduction of a sound into the cervical canal no bleeding was precipitated. Bimanual palpation disclosed a slight but smooth enlargement of the fundus uteri, which was freely movable without tenderness or presence of adnexal masses. A diagnosis of possible early carcinoma of the fundus with procidentia was made and vaginal hysterectomy recommended.

At operation, January 20, 1939, under subarachnoid anesthesia, the uterus with a round soft intramural fundal tumor was removed, and



FIG. 2. Photomicrograph of uterine muscle and embedded lipoma. There is some pressure atrophy about the tumor and a cleavage space outside the capsule.

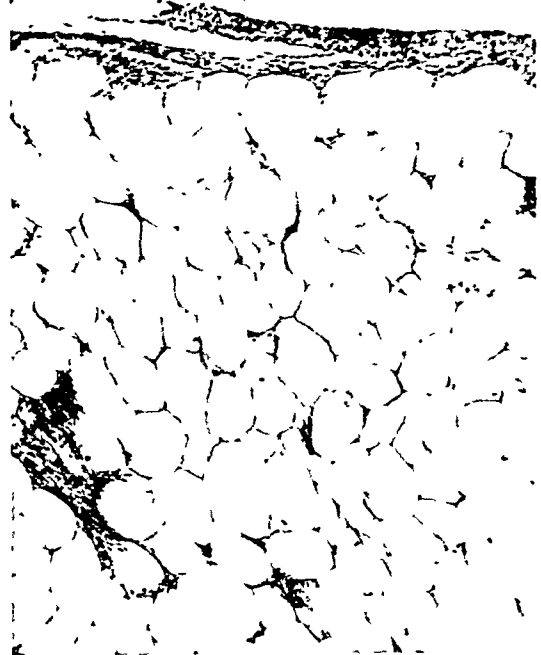


FIG. 3. Photomicrograph of tumor in the fundus. The fibrous connective tissue capsule, trabeculae and the adult type fat cells are shown.



FIG. 4. Photomicrograph of endometrium and a portion of a papillary mass. The endometrium is atrophic and glands are cystic.



FIG. 5. Photomicrograph of portion of endometrial polyp. The structure is similar to that of the endometrium. The stroma contains lymphocytes and erythrocytes. The glands are distended with secretion. The surface epithelium is denuded.

a plastic repair of cystocele followed. An uneventful convalescence followed. The patient was discharged from the hospital on the fourteenth postoperative day.

The pathologic report (by Dr. A. J. Miller, professor of pathology in the University of Louisville) was:

The uterus measured 11 by 7 by 5 cm. and was opened longitudinally on its posterior aspect. (Fig. 1.) Embedded in the muscle of the fundus was a spherical tumor 3.5 cm. in diameter. This mass was under some tension, well encapsulated, and had the color, consistency and trabecular markings of a lipoma. It distorted the cavity of the uterus slightly by pushing the fundus down, but the muscle completely surrounded the mass.

The mucosa was thin except for irregular papillary elevations 3 to 15 mm. in diameter and 3 to 7 mm. high. There were innumerable retention cysts in the mucosa, both in the atrophic portion and the papillary elevations, varying in size from those barely visible to some 3 mm. in diameter.

The cervix was fissured and scarred and some of the glands were cystic.

The muscle over the body was 2 cm. thick. Numerous sclerotic arteries protruded from the sectioned surface.

Embedded in the muscle of the anterior wall, just above the internal os, were two hard, spherical encapsulated tumors, each 15 mm in diameter. These had the appearance of leiomyomas.

Sections of the tumor at the fundus showed it to be made up of fat tissue. (Figs. 2 and 3.) There was a thin fibrous connective tissue capsule continuous with trabeculae extending into the mass. The parenchymal cells were well differentiated fat cells.

The mucosa was atrophic, consistent with senility, the stroma fibrotic, infiltrated diffusely with lymphocytes. There were numerous hemorrhages, some recent, to be attributed to manipulation. There was some partly disintegrated blood and blood pigment, indicating hemorrhage. The glands were atrophic, many of them distended with secretion and a few invaded by monocytes. The papillary elevations were similar in structure and inflammatory reaction. (Figs. 4 and 5.) The surface epithelium was partly eroded.

Sections of the tumors in the body wall revealed a structure of smooth muscle similar to

that of the uterus and a moderate amount of connective tissue stroma. There were some small, dense deposits of calcium salts about which there was degeneration.

No evidence of malignancy was noted in the tumors or the mucosa. The diagnosis was: (1) intramuscular lipoma of fundus uteri; (2) intramuscular leiomyomas of corpus uteri; (3) senile atrophy of mucosa; (4) polyposis (papillary adenomas) of mucosa with chronic inflammation and hemorrhage.

# SUMMARY

1. A rare tumor of the uterus, a true lipoma is reported, the fourth in Anglo-American literature.

2. Two leiomyomas, polyposis (papillary adenomas) of mucosa and a true lipoma are described as occurring in the one uterus.

The author wishes to express his indebtedness to Dr. A. J. Miller, professor of pathology in the University of Louisville School of Medicine, for his excellent pathologic description and photomicrographs.

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# TRIPLE PRIMARY MALIGNANCIES

## CASE REPORT

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**T**HREE separate primary malignant tumors were demonstrated in a sickly epileptic female 44 years of age who,

firm and nodular. There was a fine tremor of the tongue and rather coarse tremors of the extended fingers. The temperature, pulse and



FIG. 1. Adenocarcinoma of thyroid.

nevertheless, died from other causes. Cases of more than two malignancies in the same patient are rare, and those found are usually in individuals older than 44 at the time of death.

In the diagnosis of multiple malignancy, the most widely accepted criteria are those advocated by Hanlon: (1) the tumors must have the macroscopic and microscopic appearance of the usual tumors of the organs involved; (2) probability that one tumor is a metastasis must be definitely excluded; and (3) the diagnosis may be confirmed by the character of the individual metastasis. In the following case report these criteria seem fulfilled.

The patient, a 44 year old unmarried woman, had been feeble-minded since birth. She had had chorea as a child and epileptic attacks since the age of 25.

In the summer of 1936 she first complained of a painful nodule in the left breast of one year's duration. There was a slight discharge from the nipple and her sisters volunteered the information that she had lost about 20 pounds in weight. The left lobe of the thyroid was

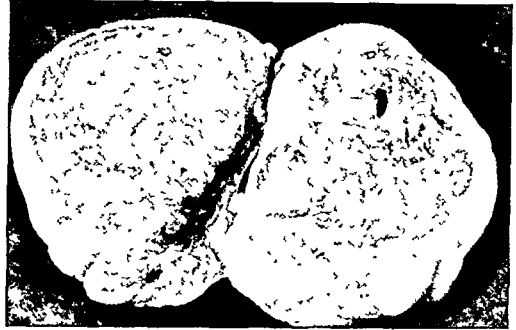


FIG. 2. Tumor of left ovary (post-mortem).

respirations were normal. The blood pressure was 140/70. X-ray examination of the chest failed to reveal evidence of metastasis.

On August 31, 1936, a radical left mastectomy was performed. The anatomic diagnosis on the removed breast was acinar carcinoma (carcinoma simplex). She made an uneventful surgical recovery and was discharged from the hospital September 21.

On February 10, 1937 she was readmitted with the diagnosis of thyrotoxicosis. After all attempts to reveal evidence of breast metastasis failed, the patient was subjected to a thyroidectomy on February 13. The anatomic diagnosis on the removed thyroid was adenocarcinoma. Again she made an uneventful recovery and was discharged from the hospital on February 28.

On August 9, 1938 she was readmitted with the history of having fallen out of bed several days previously. Her temperature was 103, her pulse 135, her respirations were shallow and numbered 32. The red count was 3,500,000, the white count 12,000, with 80 per cent polymorphonuclears. There were numerous râles in the left lower chest and the diagnosis of pneumonia was made. Despite all medication she grew steadily weaker, her breathing became very shallow and she expired August 14.

On post-mortem examination there was no evidence of recurrence of either of the two malignancies found during life. There was, however, a primary malignancy in both ovaries with metastases to the abdominal lymph glands. The left ovary was replaced by a large, rounded tumor measuring 10 cm. in diameter. The right ovary was the site of a smaller but similar tumor nodule measuring 2 cm. in diameter. Microscopic sections of these tumors revealed the very cellular picture called embryonal cell carcinoma. The left lower pulmonary lobe was airless and presented the typical picture of lobar pneumonia.

#### COMMENT

Many multiple malignancies have been reported; among these, triple cancers are rather rare. McNamara reported three distinct malignancies in addition to a basal cell carcinoma; Davis, Hanelin and Mouzakeitis reported a case of triple tumor syndrome in a 57 year old male; Drooker reviews the statistics of Warren and Gates in which triple primary malignancies comprise 2.9 per cent of all cases of multiple malignancies. Hanlon added forty-nine cases of double primary carcinoma to those seen at the Mayo Clinic but failed to find any case with three primary malignancies. Murray, in studying 4,219 cancer cases, found multiplicity in 1 per cent; Puhr, in 6,718 necropsies, found multiple malignancies in only 0.3 per cent, while Burke, in 2,033 necropsies, found an incidence as high as 7.8 per cent.

The average ages of patients with these multiple lesions were as follows: Hanlon reported an average of 55.8 years, and in twenty-four cases involving three or more organs in his own series, 62.6 years; Owen reported an average of 62.1 years; Hurt and Broders, 50.4 years.

Exclusion of the probability that one tumor is a metastasis is often difficult. Reports of multiple malignancies in the breasts are open to criticism, because of the strong probability of metastasis. Similarly in cases where primary gastric and primary ovarian cancers are reported the question of metas-

tasis arises because of the frequent spread of gastric carcinoma to ovaries. Multiple ovarian tumors, too, are questionable be-



FIG. 3. Embryonal cell carcinoma of ovaries (post-mortem).

cause of the difficulty in differentiating between primary origin and metastasis. A further complication in eliminating the factor of metastasis is the fact that a recurrence may occur many years after the apparent cure of a primary malignancy.

#### CONCLUSIONS

While multiple primary malignancies are not extremely rare, the case here presented is of interest because of three separate primary malignancies in an individual 44 years of age who had always been a semi-invalid. Despite the history of illness since birth, epileptic attacks since the age of 25, carcinoma of the breast, carcinoma of the thyroid and carcinoma of both ovaries found at post-mortem, this patient lived to be 44 years of age and die of pneumonia.

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# NEW OPERATION FOR RELIEF OF INCREASED INTRACRANIAL PRESSURE IN HEAD INJURIES

## CASE REPORT

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**O**PERATIONS on head injuries are recognized as useless and dangerous procedures except when patients

the right base and occiput, across the longitudinal sinus and the region of the posterior occipital artery and also a small linear fracture

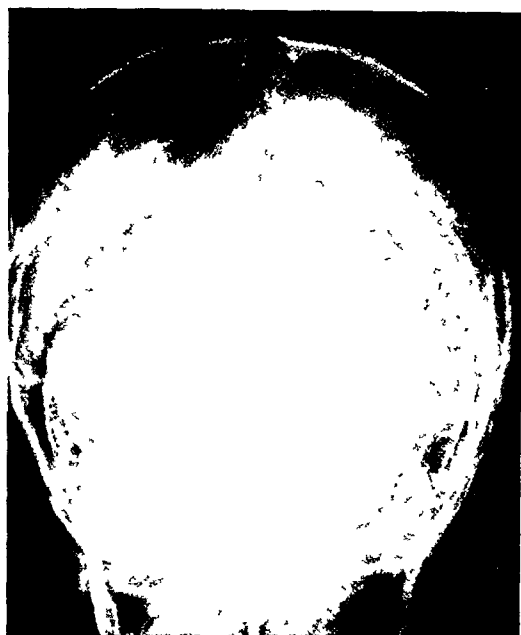


FIG. 1. Basal skull fracture on the right crossing lateral sinus and region of the posterior occipital artery.

have massive intracranial hemorrhage. The sequence of events in the following case has suggested that perhaps we may be able to help more of these patients by surgery in the critical stages.

### CASE REPORT

D. B., 7 year old boy, fell from a bicycle, striking the pavement on the right occiput. The patient was immediately rendered unconscious, regained consciousness in a few minutes, then lapsed into semiconsciousness within another few minutes. His pulse was slow and regular and of good quality. There was vomiting of blood and bleeding from the nose and right ear. There was a large skull fracture in



FIG. 2. Basal skull fracture on the right crossing lateral sinus and region of the posterior occipital artery.

entering the groove of the middle meningeal artery in the left middle fossa. (Figs. 1, 2 and 3.) There was a large ecchymosed and swollen area behind the right ear and down the right side of the neck, accompanied by ecchymosis of the left eye and cheek. A right conjugate deviation of the eyes was noted. Pupils were equal and regular and reacted well to light. The pulse became 94 and irregular. Blood pressure was 110 over zero.

Biceps, triceps and radial reflexes, when obtained, were equal. Abdominal reflexes were absent. Cremasterics were absent. Patellars were diminished and equal. Achilles reflexes were diminished and equal. Plantar reflexes were normal. There was no paralysis or sensory disturbance.

The patient resisted weakly all examination, especially the scratching of the abdomen, thighs, and the soles of the feet. He answered

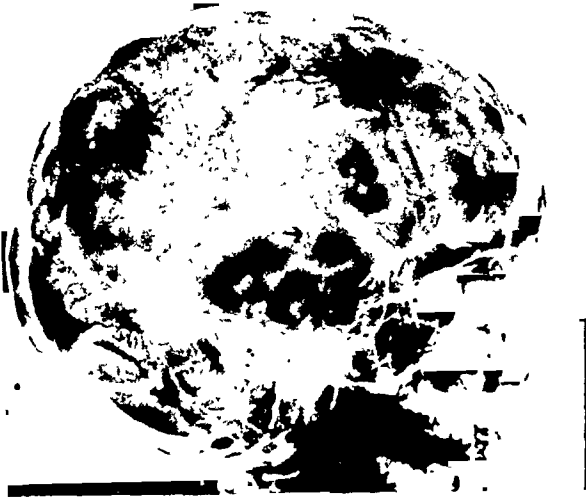


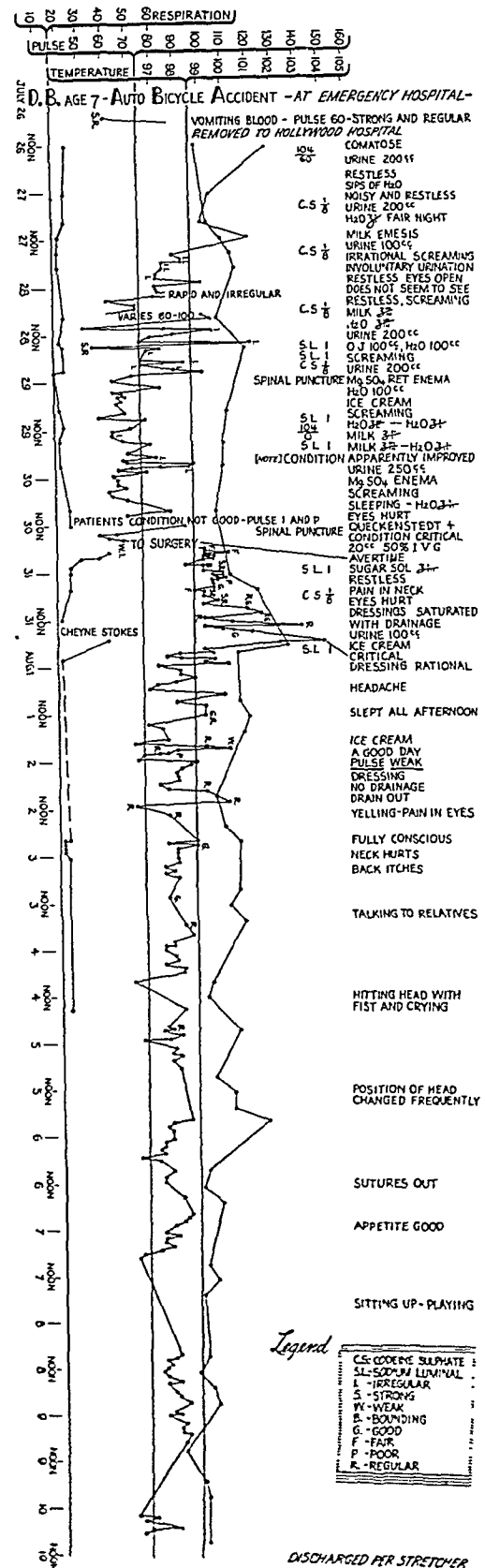
FIG. 3. This fracture runs up into the groove of the middle meningeal artery which can easily be seen in the left middle fossa. Such a fracture can be the etiologic factor in an extradural hemorrhage. Photographer in attempting to bring out clearly the small linear fracture has brought out only part of it.

questions with great hesitation but correctly. The condition was satisfactory considering the severity of the trauma although the prognosis was grave. Treatment was non-intervention and a restriction of fluid intake.

In the next forty-eight hours observation indicated that recovery would not take place. The pulse moved downward, with periods of irregularity and poor quality. Dehydration therapy was instituted by magnesium sulfate enemas and intravenous dextrose. Spinal puncture revealed a slightly bloody fluid at a pressure of 400 mm. The fluid did not flow freely after 5 c.c.

Because of the number of cases of massive hemorrhage which are undiagnosed, this condition was suspected and diagnostic trephines were advised. Surgical intervention was delayed as localizing signs were not definite enough. The pulse remained low and irregular. (Fig. 4.)

FIG. 4. (Graph at right.) D. B., age 7, July 26, 1938. Explored July 30 for possible massive hemorrhage and recovered with drainage in the cisterna magna. The critical condition on July 31 was due to too intensive dehydration. Before surgery, "1" over pulse counts indicates irregular. After surgery note that pulse counts are 1, fair; SR, strong and regular; GR, good and regular.



On the fourth day the pulse had been below 60 twice, was weaker and often irregular. Repetition of the spinal puncture revealed a

A flat  $\frac{1}{2}$  inch rubber drain was passed into the cisterna magna and carried out the upper end of the wound. The wound was closed. As

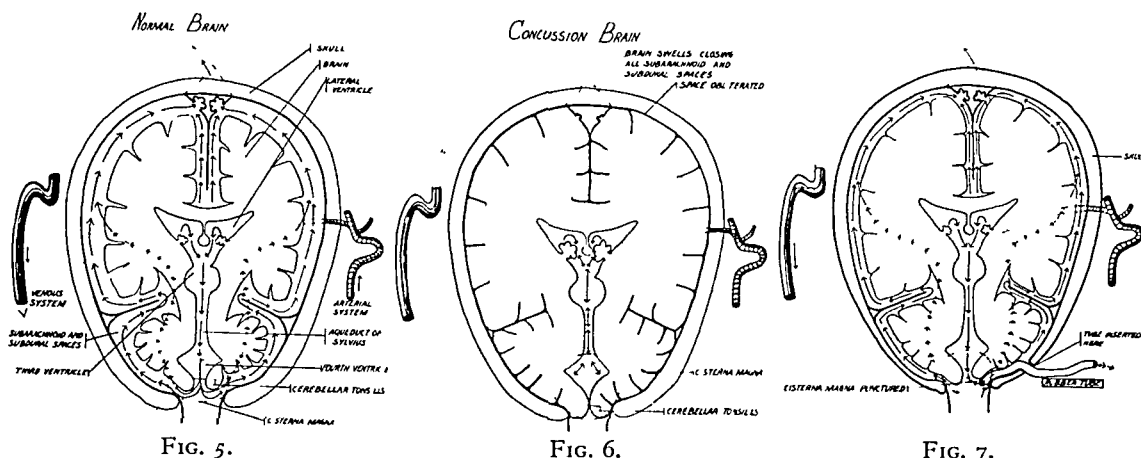


FIG. 5.

FIG. 6.

FIG. 7.

FIG. 5. Normal brain: Secretion from the choroid plexus in the ventricles. It finds its way through the subarachnoid spaces to the channels of absorption. There is much controversy as to where these are. However, the most accepted view is that they are in the pacchionian bodies.

FIG. 6. The concussion brain: All channels of absorption are mechanically blocked off by the obliteration of the arachnoid spaces. In such a condition all capillary vessels must be greatly compressed. Neither adequate blood supply nor adequate spinal fluid circulation could take place to repair damage.

FIG. 7. Schematic drawing of our drain in the posterior fossa, reestablishing spinal fluid circulation and relieving pressure by drainage of the ventricles.

pressure of 175 mm. and a complete block, which, because of bulbar symptoms, was thought to be in the region of the foramen. It was feared that the patient would die and operation was done. The operative plan was to trephine for the discovery of massive hemorrhage. The possible locations were the right occipital area, the left frontal area, and the right posterior fossa.

A small trephine hole was made in the right occipital region. There was no hemorrhage either extradurally or subdurally. The brain was pressed tightly against the dura and pulsations in the brain were faint. An unsuccessful attempt was made to tap the right lateral ventricle. The wound was closed. The floor of the right posterior fossa was exposed with a horseshoe incision. A trephine hole was made. No extradural hemorrhage was noted, but the brain was found pressed tightly against the dura. No spinal fluid escaped and pulsations were faint. It was decided that a drain placed in the cisterna magna might relieve pressure, and this was done by means of a blunt-ended grooved director. Considerable clear spinal fluid escaped. With the escape of this spinal fluid the patient's pulse, which had been running 120 and irregular during the operation, fell to 90 and became regular.

the patient's condition was so much improved it was decided that he was well enough to be returned to bed without further exploration and this was done. The patient left the table in far better condition than before the operation.

The next morning the entire bandage was saturated with spinal fluid; the patient was conscious and rational. That afternoon toxic dehydration occurred with a pulse of 150 and Cheyne-Stokes respiration. The intake of fluids was increased and this critical condition disappeared. A dry dressing was applied. The patient's condition remained satisfactory. Pulse was strong and regular. On the second post-operative day the drain was removed. The subsequent recovery was uneventful. The patient was discharged and kept in bed for six weeks. He has remained perfectly well.

Exploration was made for an extradural or subdural hemorrhage in the right posterior fossa and recovery was due to drainage in the cisterna magna. The recovery was remarkable enough to analyze for presentation as an alternative method of reducing increased intracranial pressure in head injuries, dehydration and spinal puncture failing.

Ody<sup>1</sup> of Geneva, Switzerland advocated an atlanto-occipital trepanation in 1932. He reported two cases with excellent results. The sequence of events in his cases was remarkably similar to the sequence of events in this one. He operated in the face of an apparently hopeless condition, with bad pulse and respiration, and upon drainage of the cisterna magna there was an immediate improvement and subsequent uneventful recovery. His operation approaches the cisterna magna through the midline by removing the intervening parts of the spinal canal. He places a drain in the cisterna magna at the foramen. The principles of the two procedures are the same.

The operation done here was a small trephine hole in the floor of the posterior fossa with the insertion of a rubber drain into the cisterna magna. This allowed release of pressure, readjustment of the spinal fluid circulation and decompression of the brain by drainage of the ventricular system.

Schematic drawings (Figs. 5, 6 and 7) illustrate the normal spinal fluid circulation, the blockage which takes place with an edematous brain, and the approach used.

This is possibly the simplest and most logical way to decompress the brain, other methods failing. It is submitted as a neurosurgical procedure that warrants further investigation.

#### SUMMARY AND CONCLUSIONS

1. In a critical head injury patient a drain was placed in the cisterna magna and immediate relief of increased intracranial pressure took place.
2. The method was used incidental to a negative exploration for suspected massive hemorrhage.
3. The logic of the procedure is illustrated by three schematic drawings.
4. An analogous operation by Ody is discussed.
5. The case illustrates a strictly neurosurgical procedure that warrants further investigation.

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# A CASE OF HYPERPARATHYROIDISM ASSOCIATED WITH EXTREME DENTAL CARIES

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**H**YPERPARATHYROIDISM is a rare disease. Wilder and Howell accepted as proved only 135 cases reported in the literature from 1925, the time of Mandl's description of the condition, up to June, 1935.

The diagnosis is relatively easily made provided the condition is suspected and proper laboratory procedures are carried out, namely x-ray examination of the bones, and determination of the serum calcium, phosphorus, and phosphatase. However, because the symptoms of the disease are protean and many of them not distinctive, it often goes undiagnosed. The frequently encountered lethargy, atonia, and polyuria can hardly be counted on to direct attention to the possible presence of hyperparathyroidism, but when there is a history of fractures from slight trauma, or the presence of bone pain, bone tumors, or renal lithiasis, one should always investigate for this condition.

The following case is reported because the presenting symptom, namely dental caries, had not to our knowledge been encountered previously in the recorded cases of hyperparathyroidism.

The patient was a married woman, aged 33 years, complaining of widespread dental caries. The history showed there had been a certain amount of bone pain present since childhood, especially involving the right hip and the pelvic girdle. During each of three pregnancies, nine, eleven and thirteen years before, there had been increased pain in the pelvic bones and trouble with the right hip. There had also been pain in back and shoulders. Eleven years before, while pregnant, she had probably fractured a rib by lifting her 2 year old baby and more recently she had had a possible fracture of the eleventh rib on the left following a slight trauma.

There was a profound sense of fatigue and inability to get enough sleep. The patient

stated that she could sleep fourteen to sixteen hours a day. Her appetite was exceptionally good. At times she complained of burning pain in her abdomen when hungry. There was no constipation. She showed increased susceptibility to colds and bronchitis. The menses had been quite normal.

For years, on the advice of her dentist, she had been in the habit of drinking milk, and taking calcium and cod liver oil.

The family history disclosed that there were twelve cases of carcinoma of various organs of the body in the paternal line, while in the maternal line there were many cases of tuberculosis, but there was no record of any bone disease.

On examination the temperature was 98.6°F. The blood pressure was 116/82. The most striking finding was the extreme caries involving every tooth, many of which were riddled with multiple cavities. The tonsils were large, cryptic, and contained fluid pus. The breasts were small, the left showing an inverted nipple and the right a tender nodule. The left eleventh and twelfth ribs were sensitive to pressure and there were tender points along the crests of both ilia. The reflexes seemed about normal and there was no evidence of hypotonia.

The hemoglobin was 90 per cent. The urinalysis was negative. The serum calcium was 15.0 mg. per cent, the inorganic phosphorus 2.5 mg. per cent. Roentgen ray examination of the chest, ribs, cranium and pelvis showed no evidence of osteitis fibrosa cystica, but there was moderate osteoporosis especially involving the ischial rami and the bones of the skull were definitely thickened. A diagnosis of hyperparathyroidism was made and operation advised.

At operation only one parathyroid gland could be demonstrated on each side, although an extensive dissection was carried out extending down into the mediastinum from which a small piece of the thymus was removed. Both of the parathyroid glands appeared only slightly enlarged. The one on the left was removed; the one on the right was preserved. At the same time a subtotal thyroidectomy

was also done, removing about five-sixth of each lobe; no parathyroid tissue was found in the resected lobes.

The patient made an uneventful recovery. The serum calcium had dropped to 10.0 mg. per cent on the fourth postoperative day. Following operation all bone pain disappeared and the former lethargy was replaced by irritability, nervousness, and emotional unbalance. The deep muscle reflexes became hyperactive but no Chvostek or Trudeau phenomena appeared. Four weeks postoperatively, while these symptoms were at their height, the blood calcium was still found to be 10.0 mg. per cent and the phosphorus 2.9 mg. per cent. The hyperirritability promptly subsided on administration of cod liver oil and calcium. Whether or not the dental caries will be checked remains to be determined after the passage of time.

We believe the diagnosis of hyperparathyroidism is justified in this case even in the absence of marked typical changes in the bones because of the preoperative hypercalcemia and hypophosphatemia, the return of the serum calcium and phosphorus to normal immediately after removal of the parathyroid tissue, the replacement of lethargy and hypotonia by an abnormal irritability which was relieved by calcium administration. It seems likely

that the disease had been present for a long time without greatly injuring the skeleton because of the protective effect of the self-administered calcium and cod liver oil, for it has been shown that administration of vitamin D and calcium tends to prevent skeletal decalcification, while at the same time encouraging high serum calcium and calcinosis.

Churchill and Cope have recently reported on six cases of hyperplasia of the parathyroid glands without tumor. This case probably falls into the same category. While these tumors are often hard to find at operation and while in some cases tumors have been found only after repeated explorations, the fact that such a thorough exploration was done in this case without finding a tumor, coupled with the fact that after removal of one parathyroid gland the serum calcium and phosphorus returned to normal and all symptoms disappeared, leads us to believe that the condition was one of hyperparathyroidism due to hyperplasia of the parathyroid glands.

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# INTRA-UTERINE RETENTION OF THE DETACHED FETAL HEAD

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## INTRODUCTORY NOTE

THE case reported herewith emanates from that great area of northern Arizona, northwest New Mexico and southern Utah known as Navajoland. This area comprises about 50,000 people and 16,000,000 acres of land.

These Indians are nomads, living in crudely constructed hogans, tending their herds of sheep and following the range. They have their medicine men who dance and incant before the sick to dispel the evil spirits of illness. Often it is only after failure of this ministration that the patient is brought to the Government hospital. The medicine man also acts as obstetrician as will be noted in the following report.\*

Intra-uterine retention of the detached fetal head is perhaps the most rare of the many possible complications of breech delivery. Most textbooks do not mention this accident and I have found no record of its occurrence during delivery performed by a physician.

The index catalogue of the Army Medical Library cites only one case; this occurred in a neglected breech unattended by a medical man. Plauchu presented this case before the National Society of Medicine of Lyon, France in June 1913, and reported it in the *Lyon Médical* of that year. He states that during extraction of the aftercoming head, separation may occur due to the arrest of the head by obstacles of the bony pelvis or muscles, or because of great size of the head as in hydrocephalus. It may also occur from too great forceps traction upon the head in cephalic presentations. Separation rarely occurs while the infant is

alive, but after death the tissues become friable and are more easily torn.

He was called to attend a woman with a retained fetal head, which he found in the fundus. It was easy to introduce one hand into the uterus, seize the stump of the neck with three-pronged forceps and bring the head down to the perineum. He then completed the extraction with the Mauriceau or Smellie-Veit maneuver. He states that extraction might also be done with ordinary obstetric forceps and, if necessary, reduction of the head by craniotomy or basiotripsy. If the uterus is so strongly retracted about the head as to prevent extraction he recommends total hysterectomy.

## REPORT OF CASE

Labor had commenced four days before admission. That morning the breech presented and a medicine man of the tribe, assisted by the husband, tried to do an extraction. I do not know how long they pulled, but finally the body was torn from the head and a "Sing" was started. After some time the hospital was called and my associate, Dr. Safran, arrived while the "Sing" was in progress. He found the patient lying on a blanket in the hogan with the cord issuing from the vagina and not tied. Upon inquiring about the body of the baby he was informed that it was buried and found it in a pinion tree wrapped in rags.

Physical examination upon admission revealed an emaciated Navajo primipara, 35 years old, with temperature 98.4, pulse 80, blood pressure 120/80. She was in fair general condition. The uterus was not contracted and the fetal head was palpated in the epigastrium. The labia were very edematous, the umbilical cord protruding. Pelvic measurements were: isp. 24 cm.; icr. 26 cm.; bit. 29 cm.; ext. conj. 18 cm.; diag. conj. 11; bi isch 7. DeLee gives the normal as 26, 29, 31, 20, 13, 10 respec-

\* Opinions expressed herein are those of the author and do not represent any official policy of the Office of Indian Affairs, U. S. Department of the Interior.

tively. Thus, this pelvis was contracted and funnel in type.

Operation was performed under ether anes-

perature varying between 103.4 and 98 and the pulse from 124 to 78. On the fourth day, the pulse was imperceptible and the blood pressure



FIG. 1.

FIG. 1. Body of fetus after being pulled away from intra-uterine head.



FIG. 2.

FIG. 2. Fetal head after extraction.

thesia. The cervix was dilated but not effaced, the lips being edematous and lacerated. The sacral promontory projected far into the pelvis so that the hand passed with difficulty. The head was felt high in the fundus and the placenta was in situ.

The soft parts were dilated with the hand. An attempt was made to use obstetric forceps but this was unsuccessful because of the deformity of the pelvis and the floating characteristic of the head. The cranioclast was tried, but the guiding hand and this instrument could not pass the sacral promontory together. By external pressure and internal maneuver the head was brought to the brim of the inlet. A finger was hooked under the mandible which was grasped by a tenaculum. The head would not pass and a piece of mandible came away. The skull was finally perforated with the tenaculum and considerable brain tissue evacuated with a finger. Grasps of the tenaculum took away small pieces of the head and at last a combination of external pressure and traction by the internal hand served to evacuate the head. The placenta was extracted manually without difficulty. A first degree laceration of the perineum was closed with three catgut sutures.

Twice during the operation the patient appeared weak and was given  $7\frac{1}{2}$  gr. of caffeine sodium benzoate. The immediate postoperative condition was fair and 1000 c.c. of 5 per cent dextrose in saline was given intravenously. Four hours postoperatively, the temperature was 101.4 and the pulse 110. The course continued septic for seventeen days, with the tem-



FIG. 3. Patient when ready to leave hospital.

perature not be read. An injection of 1 c.c. digitalis was given and tincture of digitalis, 1 c.c., administered by mouth every four hours. Fluidextract of ergot, 4 drams daily, was administered for seven days and sulfanilamide 60 gr. daily for seventeen days.

Blood count on the fourth postoperative day revealed hemoglobin 70 per cent; R.B.C. 4,260,000; W.B.C. 29,400; polys 87 per cent; lymphocytes 13 per cent. The Wassermann and Kahn tests were negative. On the seventh day there was considerable abdominal distention which was relieved with pituitrin. On the ninth day sulfanilamide was suspended for three doses. That evening the patient had a severe chill with temperature of 103.4°F. Sulfanilamide was again given; the temperature was 99 the next afternoon and then continued up and down for the next week.

Vaginal examination on the sixteenth day revealed a mucopurulent cervical discharge; the lacerations were healed and the cervix firm. The uterus was retracting but the parametrial tissues were indurated and fixed. A large, apparently decubital, area was noted on the right buttock, although all precautions, such as use of a bed-ring, had been taken. This area had softened and become fluctuant on the eighteenth day. It was opened and drained under evipal anesthesia. At this time daily warm potassium permanganate douches were started and given for about three weeks. Fourteen days after opening the abscess, the cavity had become clean and stopped draining. Under local anesthesia the cavity was curetted, the wound edges freshened and obliterating sutures inserted. Eight days later the sutures were



removed and the wound treated daily with the infra-red lamp. The patient was allowed out of bed, and on her fifty-second hospital day was discharged. Final vaginal examination showed the cervix normal in appearance, the uterus anteflexed but drawn to the left and not freely movable. There were no adnexal masses or tenderness. A slight vaginal discharge was present.

#### SUMMARY

The literature and etiology of intra-uterine retention of the detached fetal head in breech presentation is reviewed. An abstract is given of the only previously reported case.

A case in an Indian primipara on the Navajo Reservation is reported.

The head was extracted with great difficulty, and then only after perforation, due to disproportion of the pelvis.

Convalescence was stormy; but sepsis was combated by sulfanilamide therapy and the eventual recovery was complete.

The author desires to express his appreciation to Dr. James G. Townsend, Director of Health, Office of Indian Affairs, and to Dr. W. W. Peter, Medical Director, Navajo Service, for permission to publish this paper. Appreciation is also expressed to Dr. Nathaniel Safran, Junior Physician, Western Navajo Hospital, who assisted in the operation and gave valuable assistance in the care of the patient.



# ANTENATAL VOLVULUS WITH STRANGULATION AND PERFORATION INVOLVING A PORTION OF THE ILEUM\*

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A 20 year old primi gravida at term was admitted February 1, 1937 to the Methodist Episcopal Hospital of Brooklyn. She had had irregular labor pains of approximately sixteen hours' duration. Her clinic record covering the last trimesters showed a negative Kahn and Wassermann, normal blood pressure, negative vaginal smear for yeast and trichomonas vaginalis, and an occasional very faint trace of albumin in the urine. Her pelvic measurements were not remarkable except for a narrowed outlet of 7.5 cm.

After a thirty hour labor, during which nembutal gr.  $7\frac{1}{2}$  and codeine sulfate gr. 2 were given, the patient was delivered by one of us (D. A. J.) under gas-oxygen-ether anesthesia. The fetal heart was heard throughout labor. An episiotomy was done and small Simpson forceps were used to assist in delivery of the head, which presented in the ROA position. Moderate difficulty was then experienced in delivering the body. This was found due to a considerably distended abdomen presenting a thick leathery wall marked with a few scattered areas of ecchymosis. The child, a female weighing 7 pounds 2 ounces breathed irregularly and showed marked pallor and flaccidity, especially of the extremities. Its temperature was 96°F. and it lived only two hours despite injections of alpha lobelin and adrenalin, and frequent oxygen administrations. No bowel movements or vomiting were recorded during this period. Before death the clinical impressions included: polycystic kidneys, basilar hemorrhage, Hirschsprung's disease, intestinal stenosis, and abdominal trauma.

The post-mortem examination (E. B. Smith) revealed marked cyanosis of the head and extremities. The anus was open and protruding. The abdomen was markedly distended. About 200 c.c. of dark brown fecal-like fluid escaped when it was opened. A greatly dilated loop of

ileum was lightly adherent to the under surface of the liver. The mesentery had undergone a complete turn in a *clockwise* direction with torsion and compression of the vessels at the root. Four loops of ileum lay parallel to each other, included in the volvulus. The three proximal loops were dilated, their walls edematous and thickened. The serosa was red and shiny, the vessels engorged. The distal loop adhered to the liver and was dilated to a diameter of 4 cm. Its walls were dark red with purplish areas, the serosa dull. A perforation at the right-hand end allowed intestinal contents to escape. The remainder of the ileum was 8 mm. in diameter and appeared normal. All other abdominal organs were normal in size, position, and development and showed no gross pathology.

Sections were made of one of the strangulated loops of ileum. The wall was thickened and there were small extravasations of blood here and there. The lumen contained blood. The tissue showed no evidence of necrosis.

The liver cells showed granular degeneration.

The diagnosis was: Volvulus neonatorum (ileum), accompanied by strangulation of ileum, spontaneous perforation of ileum and granular degeneration of the liver.

## DISCUSSION

In explanation of the factors responsible for abnormal rotation, we must consider briefly the development of the gastrointestinal tract in the embryo. Fundamental work on the development of the intestine and its anatomic position was done by Mall<sup>7</sup> (1898). Frazer and Robbins<sup>3</sup> (1915) among others, also contributed much to the knowledge of intestinal rotation. More recently, since the very comprehensive report of Dott<sup>2</sup> (1923) a flood of articles on

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malrotation and its complications have appeared.<sup>1,4 5 6 9-13</sup>

The primitive alimentary canal develops

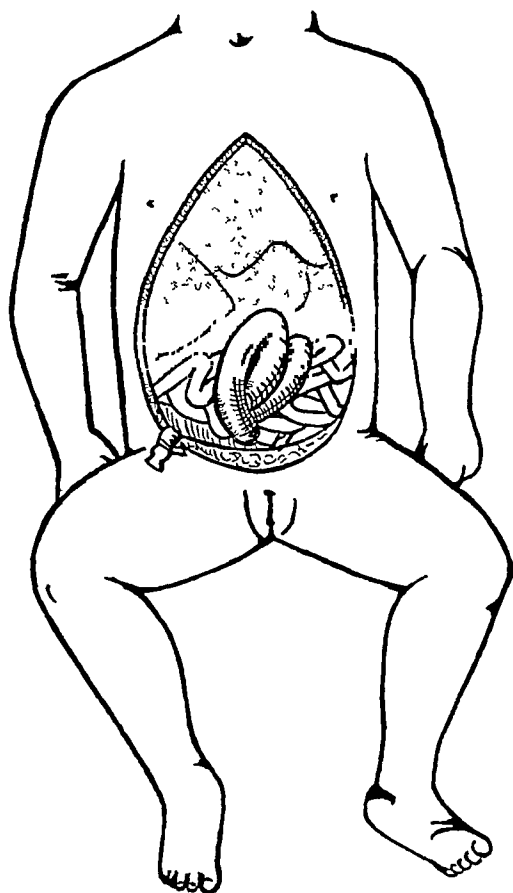


FIG 1. Semidiagrammatic sketch to show dilated loops of ileum at the site of the volvulus.

from endoderm and is soon roughly divisible into three portions. However, the midgut, because of its mobility, is the chief site of abnormal rotation, and it is here that the present ileal volvulus occurred. The midgut stretches from the biliary papilla through the jejunum, ileum and the right end of the transverse colon. It is supplied by the superior mesenteric artery and flanked by the foregut (stomach and duodenum) above, and the hindgut (left end of the transverse and the whole of the descending colon) below.

Somewhere about the tenth or eleventh embryologic week this rapidly elongating midgut loop, which previously has been forced out into a sort of umbilical hernia

by the growing liver, is returned to the abdominal cavity, and rotates (normally) *counterclockwise* 270 degrees about the axis of the artery. This places the duodenum behind, and the transverse colon in front of the mesenteric vessels. *The exact timing of the return of these viscera into the abdomen is held to determine their relative disposition.* It may be at this particular stage that the present volvulus occurred, i.e., four loops of the ileum were rotated (abnormally) *clockwise* 360 degrees. Moreover there was no apparent defect, consequent to malrotations, in the mesentery or its attachments, such as noted in the literature<sup>2 4 13</sup> which might account for this abnormality.

As a precipitating factor in infant volvulus one must discard in this case the theory of active persistalsis incident to the first food taken,<sup>4</sup> for this infant received no feedings before it died two hours after delivery. In addition it should be noted that the entire midgut did not join in the abnormal rotation, and thus this case differs from one type of malrotation that has been reported.<sup>2 9</sup> Finally, the strangulation and perforation present in the ileum afford interesting ground for speculation. From the pathologic evidence they appear to have developed long after the volvulus is supposed to have been formed.

Several questions, unanswerable at present, immediately arise: Is there some physiologic activity of the bowel only present shortly before birth? And did this precipitate the strangulation of the twisted loops with the sequence of perforation and death? Or is the thirty hour labor to be taken as the chief factor in the strangulation?

#### SUMMARY

1. A case of antenatal volvulus of the ileum with death two hours after birth is presented.

2. A brief survey is made of gastrointestinal development with some emphasis on the *normal* rotations of the primitive midgut, to bring out more clearly the *abnormalities* in rotation, of which this case furnishes an unusual example.

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It can be fairly stated that bleeding from the bowel is the most important single symptom pointing to organic disease of the intestinal tract. . . . It is an indication of a break in the mucosa of the bowel somewhere along its course, or in the epithelium of the anal canal.  
From—"The Rectum and Colon" by Hayden (Lea & Febiger).

# SUCCESSFUL REMOVAL OF A GANGRENOUS APPENDIX IN A PREMATURE NEWBORN\*

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**T**HIS case is reported because the patient is younger than any recorded in the literature and because it serves to call attention to the incidence of acute appendicitis in irreducible scrotal hernia of the infant.

Baby S, a 6 day old negro male, was admitted to Freedmen's Hospital November 27, 1938 because of swelling of the scrotum and persistent vomiting. Two days previous the mother had first noted a swelling of the right scrotum, and the next day, the baby became fretful, cried almost constantly, vomited everything, and had no bowel movement. The swelling increased in size.

The infant had been delivered at home, November 21, a premature of  $7\frac{1}{2}$  months. The baby weighed only 4 pounds at birth but was apparently healthy and strong and had been taking breast feedings well.

On physical examination, it cried whenever handled, the lips were dry and tongue coated. Its weight was 3 pounds 1 ounce. The right side of the scrotum contained a mass  $2\frac{1}{2}$  cm. in diameter which was tense and apparently tender. The mass extended up to the external ring where it narrowed and disappeared in the lower half of the inguinal canal. It did not change in size during crying. The adjacent abdomen was normal. The right testicle could not be distinguished from the swelling, but the left testicle was of the expected size and in the dependent portion of the scrotum.

Temperature was 101 and pulse 120, respirations 28. The red blood cells numbered 6,350,000, the whites 8,450.

A diagnosis of strangulated right indirect inguinal hernia was made, the scrotum elevated, the baby sedated and placed in Trendelenburg position.

During the next six hours the baby had a bowel movement and vomiting ceased, but the

mass did not reduce in spite of sleep. Conservative therapy was, therefore, abandoned. By the time an operative permit was obtained, another eight hours had passed and definite redness and local heat of the skin had developed.

*Operation.* Without anesthesia the conventional incision employed for inguinal hernia was made and extended down over the base of the scrotum. The cecum was found in its usual position inside the internal ring, but the appendix traversed the entire length of the inguinal canal into the scrotum. Distal to the external ring it was gangrenous and united in a purulent mass with a bilobed testis which was twice the diameter of the left testicle. There was free pus present and all structures including the skin were edematous and thickened. The appendix was amputated; the stump inverted, and the internal ring closed. Silk sutures were used throughout. The testicle was separated from the gangrenous portion of the appendix and replaced in the scrotum. The skin was sutured with a few silk sutures and the dependent portion of the scrotum drained with a small bit of rubber tissue. The baby left the operating table in good condition.

*Postoperative Course.* The temperature rose to 104 degrees on the day following operation and then dropped from day to day. No physical signs or symptoms of peritonitis developed. During the first three postoperative days the patient was given a clysis of 50 c.c. of normal saline in the buttocks twice daily. He was given two hour feedings and the usual treatment for prematurity. The feedings were well taken, but the baby did not begin to gain weight until a week after operation. The wound drained freely and developed redness of the skin edges. The rubber tissue was removed on the third day because adequate drainage was being established by separation of the edges from the midportion of the incision to its most distal extremity. The skin sutures were removed over

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this entire area on the fourth day. Healing then became very sluggish, as is characteristic of the process in undernourished, partially dehydrated infants. Vitamin c was added to the diet in rather large quantities in the hope that it might stimulate repair. There was some apparent improvement. The wound completely healed eighteen days after operation. At this time the baby's weight was 3 pounds 14 ounces. When it was approximately three months old, it weighed 6 pounds. A definite hernia in the region of the scar was noted, but the right testicle was only slightly larger than the left.

#### COMMENT

The pathologic report confirmed the diagnosis of gangrenous appendicitis. The attempt to save the right testicle was of doubtful efficacy.

Appendicitis has been described at all ages. Mason and Hill<sup>1</sup> reported a case with death on the third day of life which apparently developed prenatally. Christowa<sup>2</sup> has also reported an inflamed appendix causing death from peritonitis in a three day old infant. Abt,<sup>3</sup> in 1917, collected from the literature eighty cases of appendicitis occurring in infants under three years of age. A generous percentage of these in males were in strangulated inguinal herniae. In the twenty cases under three months of age, sixteen were in males and eight were in strangulated herniae, an incidence of 50 per cent. There were four males in the group

between three and six months but none were in herniae. Between six months and a year there were seven males and two had strangulated hernia or an incidence of 24 per cent in strangulated hernia in the males. The incidence is so high that the possibility of the appendix being involved in a right sided strangulated inguinal hernia in the male infant must always be considered. The development of the gangrene undoubtedly originates mechanically from an occlusion of the blood supply. The prognosis with treatment is invariably good. Of the fourteen cases cited by Abt all recovered. The youngest patient reported in the literature was 12 days old,<sup>4</sup> and the next youngest fourteen days, reported by Kramer.<sup>5</sup> Another of the same age was reported by Hoffman.<sup>6</sup> Bachy and Rabourdin<sup>7</sup> have recently called attention again to the occurrence of appendicitis in right sided herniae in males of all ages.

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# NEW INSTRUMENTS

## THE CAHAN NAIL EXTRACTOR\*

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THE instrument is designed to extract nails placed in the neck of the femur when it is in use, and as a backstop for the cylindrical weight when it is moved backward during the extraction maneuver.

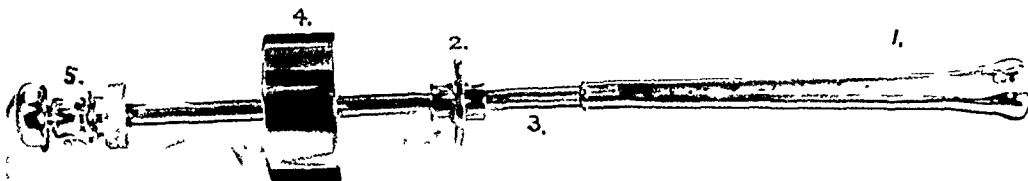


FIG. 1. The Cahan nail extractor.

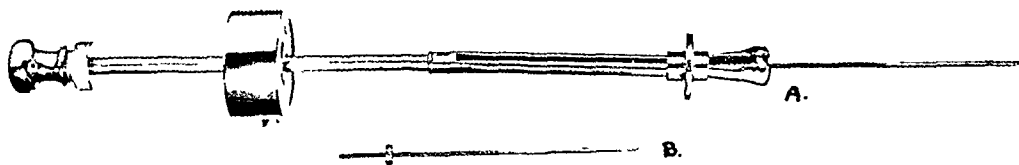


FIG. 2. A, the nail extractor with the jaws closed over the head of a Moore nail. B, a Moore nail.

fractures. Its purpose is to accomplish this removal with a minimum of trauma to the surrounding bone and soft parts.

The instrument is based on the principle of the carpenter's hammer, which drives a nail home by the application of force to the head of the nail; the extractor drives the nail out by the application of a similar force in the opposite direction.

The extraction is accomplished (Fig. 1) by the use of a pair of jaws, "1," clamped on to the nail head by means of a sliding sleeve, "2." This part of the instrument is continuous with a straight shaft, "3," upon which slides a cylindrical weight, "4." This functions as does the head of the carpenter's hammer. At the end of the shaft is a steel bolt, "5," which serves a double purpose: It acts as a handle for the instrument

When in use, the shaft of the instrument is placed in line with the axis of the nail, the jaws are placed over the head of the nail and the sleeve is slid forward as far as it will go, thereby locking the jaws over the nail head. (Fig. 2A.) Then with the handle between the thumb and first two fingers of the left hand, the cylindrical weight is moved forward with the right hand along the shaft up to the junction of the shaft and the jaws of the instrument; it is then moved back so as to deliver a sharp blow against the backstop. One to several such blows will usually suffice to extract the nail.

This instrument has been used by Dr. Nelson W. Cornell to extract Moore nails (Fig. 2B) in a small series of cases. In each instance the procedure has been accom-

\* From the Department of Surgery, New York Hospital and Cornell University Medical College.

plished satisfactorily through a small skin incision. It is to be noted (1) that no leverage is used against the femur itself or any other part of the patient's body to secure countertraction for the instrument; (2) that the force of extraction is applied directly in line with the longitudinal axis of the nail, thus minimizing trauma to the bone in which the nail is embedded; and (3) that the nail is extracted as easily as it is hammered into place, for, in effect, it is hammered out in the same manner.

## SUMMARY

1. An instrument is presented that is designed to extract nails from the neck of the femur, and is known as the "Cahan Nail Extractor."
2. In action, this extractor is analogous to the hammer which hammers the nail out of its bed.
3. The use of the instrument involves a minimum amount of adventitious trauma and a maximum of ease for the operator.



*Correction:* It has been brought to our attention that the name of the coauthor of an article by Dr. Kimpton in our August, 1940, issue should have read A. Reynolds Crane and not D. Reynolds Crane.





S P E C I A L M O N O G R A P H

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# The Surgery OF Mediastinal Tumors

BY

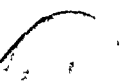
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# THE SURGERY OF MEDIASTINAL TUMORS\*

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THE mediastinum harbors an extraordinary variety of benign and malignant tumors. A survey of our own experience and a review of the literature shows that these include the dermoid cysts and teratomas, the cysts of endodermal and mesodermal origin, the cystic lymphangiomas and the echinococcus cysts. The connective tissue tumors include fibromas, lipomas, leiomyomas, xanthomas, chondromas, chondromyxomas and chondrosarcomas. *Neurogenic tumors include neurofibromas, ganglioneuromas, neuroblastomas and neuroepitheliomas*, the benign and malignant tumors of the thymus gland; the primary tumors of the mediastinal lymph nodes include lymphosarcoma, Hodgkin's disease and endotheliomas, the primary and secondary sarcomas, the rather heterogenous group of primary and metastatic carcinomas and the intrathoracic goiters. The very number of the lesions precludes a full consideration of them, yet an effort will be made to cover their salient features. Before doing so, some general statements will be made regarding the symptomatology, diagnosis and treatment of mediastinal tumors which apply more or less to all of them.

Occasionally a mediastinal tumor may be asymptomatic and is discovered during the course of a routine physical examination. But when mediastinal tumors give rise to symptoms these may be of two kinds, general or local. By general symptoms we mean the common symptoms of pain in the chest, cough, dyspnea and cyanosis. They are the result of mediastinal compression, and vary with the size and location of the lesion and degree of compression of various mediastinal structures. The pain may be dull and aching, may be sharp like that in pleurisy or may be dull and boring as in aneurysm. It may be local and referred to the region of the tumor, or it may be referred a considerable distance. The cough usually is irritative, absent at times and again distressing. Irritation of the pleura or of a bronchus by pressure is usually the cause. It is frequently accompanied by a scanty mucoid expectoration, but may be associated

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with bloody sputum, at times with severe hemoptysis, with the expectoration of pus or of hair, tumor fragments or other material of value in diagnosis. Dyspnea is a variable symptom but at some stage of the disease manifests itself with great regularity. It is sometimes inconspicuous in large tumors but may be disturbing in small tumors. It may or may not be associated with cyanosis.

In addition to these general manifestations of mediastinal tumors are other signs which may be designated as local in the sense that they are visible through local swellings or are due to implications of structures in the immediate neighborhood of the lesion. Visible swelling over the chest or in the suprasternal region, in rare instances with pulsation, dilatation of the veins of the neck and front of the chest sometimes associated with edema of the face, inequality of the pupils or a definite Horner's syndrome, hoarseness due to pressure upon the recurrent laryngeal nerve, dysphagia due to pressure upon or dislocation of the esophagus, herpes or neuralgia due to pressure upon intercostal nerves, all are manifestations of mediastinal tumor observed with variable frequency, some of which at times have a definite localizing value. The occurrence of Horner's syndrome, for example, suggests not only a lesion of the posterior mediastinum but one involving the paravertebral sympathetic chain.

The symptoms just enumerated, it will be observed, are due largely to mechanical causes; and not infrequently death in mediastinal tumors is due to mediastinal compression and its effects upon the respiration and circulation. In malignant lesions, anemia, loss of weight and strength and irregular fever occur as in other malignant tumors but are seen less frequently, due, perhaps, to earlier death from compression symptoms. It should be recognized that tumors of the mediastinum may cause symptoms referable to the spinal cord; conversely, tumors arising within the spinal cord may extend into the mediastinum.

In the diagnosis and differential diagnosis of mediastinal tumors, all the resources of the internist, roentgenologist, bronchoscopist and surgeon may be necessary. Careful physical, roentgenographic, bronchoscopic and sputum examinations will serve in some cases not only to establish the presence and location of a lesion but also its pathologic nature. In other cases the application of these diagnostic methods succeeds in establishing the presence of a mediastinal tumor but fails to indicate its nature. In some of these, and especially those near the thoracic wall, an aspiration biopsy may

serve to establish the pathologic diagnosis, in others, the removal of an accessible involved gland, and in still others the response of a lesion to a controlled dose of roentgenotherapy. But experience shows that in not a few cases all our present diagnostic methods fail to establish the pathologic nature of the tumor, although they do establish its presence and its location within the mediastinum.

Confronted with this situation, the thoracic surgeon, in the diagnosis of certain mediastinal tumors, comes to rely upon his experience first, with respect to the kind of shadow in the roentgenogram cast by various mediastinal tumors and second, with respect to the predeliction of certain tumors for certain locations in the mediastinum. Neither of these criteria is infallible, but they not infrequently serve to differentiate between a benign tumor amenable to surgical removal and a malignant lesion which is inoperable. Certainly in our experience a clearly defined, circumscribed shadow in an x-ray film is most often cast by a benign tumor; although it does not rule out such lesions as ganglioneuromas or teratomas which have undergone malignant degeneration, certain sarcomas, or lesions other than tumor, as mediastinal abscess and non-pulsating aneurysms. Again, in our experience, the diffuse, poorly defined, irregular shadow is most often associated with malignant conditions, a finding to which also there may be exceptions. Less important than the x-ray is the diagnostic information obtained from the particular location of the lesion. Tumors in the posterior mediastinum are particularly apt to be the ganglioneuromas or other neurogenic neoplasms arising from the sympathetic chain or thoracic nerves, or the various forms of chondroma arising from the costo-vertebral articulation or intervertebral discs. The dermoid cysts almost always occur in the anterior mediastinum, and so on. Frequently, however, such distinctions have no meaning, for tumors, when they reach any considerable size, may defeat all efforts to determine their exact site of origin. It must be admitted, when all is said, that one of the handicaps to more intelligent treatment of mediastinal tumors lies in our diagnostic limitations.

The indications for treatment and the kind of therapy advisable for the various tumors of the mediastinum may here be touched upon in a general way, leaving fuller discussion of these matters to our later consideration of individual groups of tumors.

A question which appears to arise with increasing frequency is what our attitude should be toward the mediastinal tumor without

symptoms or with insignificant symptoms. There seems little doubt that various benign tumors may fail to provoke symptoms over long periods of time. The occasional finding in an aged individual of a tumor which, because of its nature, must have originated early in life, even suggests that a person may carry a tumor throughout life without serious impairment of health. There is evidence to show that some benign tumors undergo slow and continuous growth as might be expected; that others, having reached a certain size, become for a time quiescent or grow so slowly that their growth cannot, over a period of several years, be demonstrated in the x-ray film; that still others, after a period of quiescence, again may begin to grow, and that this secondary activity may indicate a malignant change in a previously benign tumor. As a general rule we think it can be said that tumors without symptoms or with insignificant symptoms may be expected to provoke symptoms sooner or later because of simple enlargement or malignant degeneration. Our own experience and a review of the literature suggests that the individual who continues to harbor a benign tumor is subject to definite danger. Among thirteen cases of dermoid cyst and teratoma in our own series, five had undergone malignant change at the time they came under our observation. In a review of 217 cases of dermoid cyst in the literature we find that forty-seven patients remained untreated and all died of the disease. Of twenty-eight cases of lipoma of the mediastinum, thirteen patients were not treated and all died; and in seven death was directly due to the lesion. In eighteen cases of fibroma of the mediastinum, thirteen patients were not treated and all died; in five the tumor was removed and all recovered. We could enlarge upon such data as these. The point we wish to make is that the lack of prominent symptoms in mediastinal tumor is to the individual a fortunate circumstance but does not necessarily imply that the lesion is quiescent, that it may not undergo malignant degeneration or that it may not eventually cause his death if not removed. It would seem wise seriously to consider surgery in this group of cases.

In the treatment of mediastinal tumors the question of surgical removal or roentgenotherapy naturally arises. From our own experience there would appear to be a tendency on the part of the profession to treat mediastinal tumors primarily by radiation. The opinion seems to be prevalent that x-ray therapy may achieve satisfactory results; and if it fails to do so, surgery then may be considered. We would suggest that this attitude be reversed; that upon the discovery



of a mediastinal tumor the surgeon, experienced in thoracic surgery, should be consulted; and not until he has concluded that surgery is inadvisable should x-ray therapy be undertaken. As we shall point out, certain benign tumors and some of the malignant tumors are amenable to surgical removal and in general these fail entirely to respond to x-ray therapy. Not only does x-ray fail to reduce their size but it may fail also to prevent their malignant degeneration. It may make subsequent attempts at surgical removal more difficult and hazardous because of the production of massive adhesions. It may be not only a wasted effort but one productive of harm to the patient.

A survey of our own cases shows that the dermoid cysts and teratomas, the various other mediastinal cysts, the intrathoracic goiters, the benign connective tissue tumors including those derived from cartilage, the benign tumors of neurogenic origin, the benign tumors of the thymus gland and certain primary but circumscribed sarcomas lend themselves to surgical removal; while the primary malignant tumors of the mediastinal lymph nodes (lymphosarcoma, Hodgkin's disease, etc.), the malignant thymomas and the various mediastinal carcinomas have proved unsatisfactory from the viewpoint of surgery. Such a rough grouping of cases at least indicates *which of the various mediastinal tumors had best be treated primarily by surgery and which by x-ray therapy*. The proportion of the total number of cases amenable to surgery as seen in a general hospital (New York Hospital) is suggested by our experience. In 145 cases of tumor of the mediastinum observed in the medical and surgical wards, 107 are examples of malignant disease and thirty-eight are examples of benign tumor. Of the 107 cases of malignant tumor, forty-seven are primary malignant tumors (lymphosarcoma, Hodgkin's disease) of the mediastinal lymph nodes, thirty-one are malignant tumors of the mediastinum secondary to cancer of the lung, twelve are malignant tumors secondary to other malignant conditions and seventeen are primary malignant tumors of the mediastinum. In this group of malignant lesions, surgery was contemplated only in the seventeen primary malignant tumors and of these surgical exploration was carried out in twelve. In six the tumor proved inoperable, in six the tumor was removed. Of the thirty-eight cases of proved or presumed benign tumor operation was performed in seventeen, in sixteen of which the tumor was removed. Of the twenty-one cases in which operation was not performed, sur-

gical opinion regarding operability was not requested in five; in five admission to the hospital was so late and symptoms so advanced that surgery could not be considered; in two symptoms were so slight that agreement regarding operation could not be obtained and in eight operation was refused. Of these twenty-one cases, six patients are known to be dead, eleven were followed for a time but cannot now be traced and presumably are dead and four are living and being followed. The total experience shows first that with earlier diagnosis a greater number of the primary malignant tumors may come within the field of surgery and second, that a larger percentage of the benign tumors should be subjected to surgery.

In addition to the tendency to delay in the surgical treatment of benign tumors as indicated by the twenty-one cases above noted, is the tendency to be deterred from seeking surgical relief because of the size of certain mediastinal tumors. The literature contains reports of patients with large tumors who have died from mediastinal compression symptoms and who, at autopsy, presented large tumors unattached to vital structures and easily removable. In general in these cases, the long duration of symptoms, the finding of a circumscribed shadow and the fact that the patients have, not long since, succumbed to the disease, suggests that the lesion was benign and did not involve essential structures within the mediastinum. We have removed tumors weighing as much as eight pounds with remarkably little effect upon the individual. The removal of such large tumors is a mechanical problem which may indeed present difficulties but these, with our present facilities, are not insurmountable.

#### OPERATIVE TECHNIC

Perhaps only three matters in the operative treatment of mediastinal tumors require comment. These are the choice and method of anesthesia, the surgical approach to the lesion and the closure of the thoracic wound.

*Anesthesia.* We have found that intratracheal anesthesia is the most satisfactory method in mediastinal tumors. The intratracheal tube may be introduced in the usual way under laryngoscopic observation or through the nose according to the method of Magill. As a method it has the advantage of relieving the surgeon of his fears of respiratory upsets when one or both pleural cavities are widely opened. If administered by skilled anesthetists, anesthesia generally is smooth and satisfactory. A variety of anesthetic agents

may be used with this method. Ether and oxygen alone is highly satisfactory and when in doubt, either with respect to the skill of the anesthetist or the condition of the patient, is perhaps the anesthetic of choice. Nitrous oxide-oxygen, combined if necessary with ether, has proved quite satisfactory with us. Better, however, in our experience, is cyclopropane gas with which a smooth anesthetic without a trace of cyanosis may be given even when both pleural cavities are opened.

*Surgical Approach.* The location and the size of the lesion determine the thoracic approach. Generally speaking, we have found that three surgical approaches will usually adequately expose the majority of mediastinal tumors. These are the anterior, lateral and posterior approaches.

*Anterior Approach.* This approach is applicable to tumors of small to medium size situated in the anterior mediastinum. An incision is made over the costal cartilage and rib most nearly corresponding to the midpoint of the tumor as shown in the x-ray film. The fibers of pectoral muscle are divided and a generous subperiosteal resection of the rib and costal cartilage to its sternal junction is made. If the tumor be small, an incision is made through the posterior periosteum of the resected rib, the pleura opened and exposure obtained with a proper rib spreader. If the tumor prove to be too large for delivery through the opening obtained, the approach can immediately be enlarged in the following way: A vertical incision is made along the right or left sternal border at right angles to the previous transverse incision. The costal cartilage above and below that previously resected is exposed and divided at its junction with the sternum. The rib spreader now produces a large triangular opening, its base at the sternal margin, and its apex at the lateral thoracic wall. (Fig. 1.)

*Lateral Approach.* This is applicable to the large mediastinal tumors which have extended laterally into one or other pleural cavity. A long incision encircling the hemithorax is made over the rib corresponding to the midpoint of the tumor. Such muscles as cover the rib are separated or divided. With the exposure of the rib the question arises whether to make an intercostal incision between it and the adjacent rib or to resect a long segment of the rib subperiosteally and open the pleura through its posterior periosteum. Either method may be used. After an experience with both methods we believe the approach to the pleural cavity through the posterior

periosteum of a resected rib to be more desirable because subsequent closure is more satisfactory. With the pleura opened a rib spreader is used to expose the wound as widely as may be necessary. In

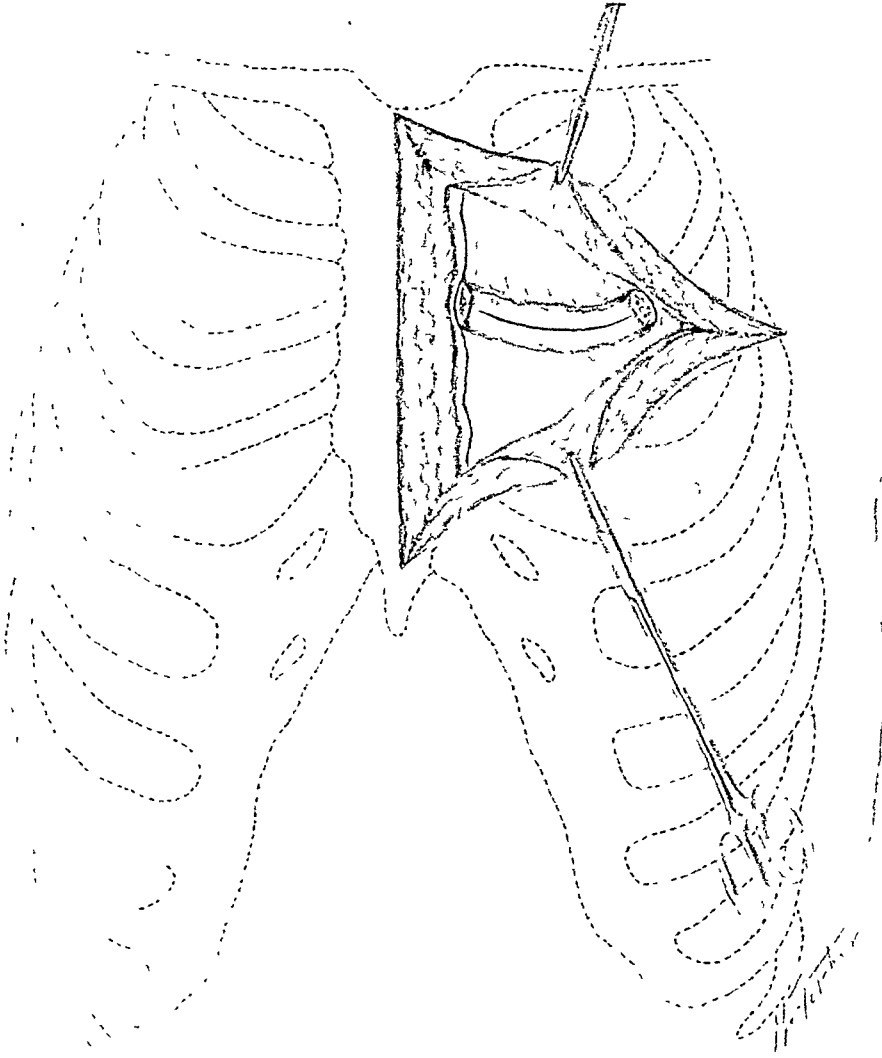


FIG. 1. Operative approach, anterior. (From Pack and Livingston's "Cancer and Allied Diseases," Paul B. Hoeber, Inc.)

cases with unusually large tumors in which the tumor cannot be delivered through the opening obtained, a rib or ribs above or below the rib resected may be divided at one or both ends of the incision making a trap-door type of approach. (Fig. 2.)

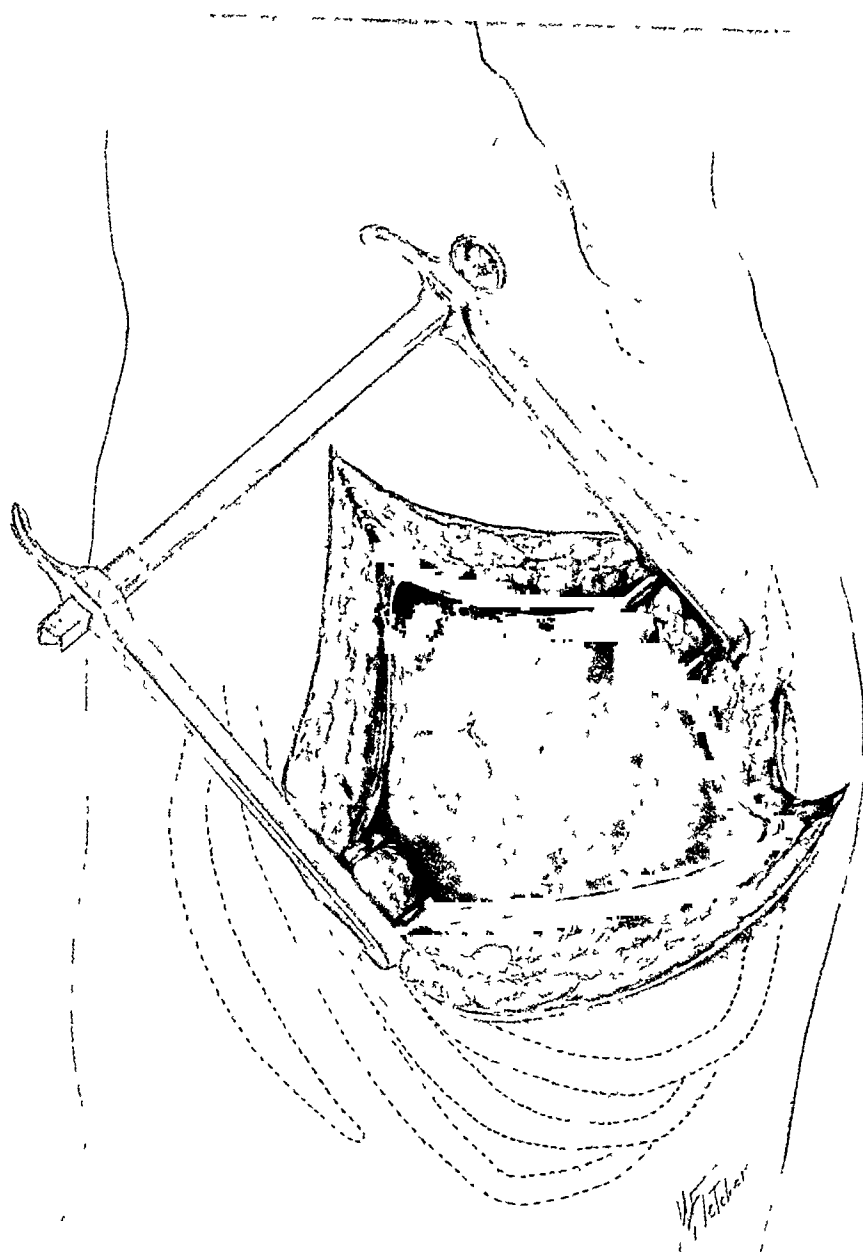


FIG. 2. Operative approach, lateral. (From Pack and Livingston's "Cancer and Allied Diseases," Paul B. Hoeber, Inc.)

*Posterior Approach.* This is satisfactory for the tumors which occupy the upper posterior mediastinum. An incision is made between the spine and scapula which, below the latter structure, is curved laterally so that the scapula may be retracted outward. The posterior muscles attaching the scapula to the spine are divided, the scapula is strongly retracted laterally and the underlying ribs exposed. Sufficiently long segments of the ribs overlying the tumor are resected subperiosteally and a flap consisting of intercostal muscles and the posterior periosteum of the resected ribs reflected in whatever direction seems best suited to the individual case. It is used in the subsequent closure of the wound. The pleura is opened widely and appropriate rib spreaders give an exposure sufficiently large for all but the really large tumors. (Fig. 3.)

Certain technics within the thorax which we have found useful may briefly be mentioned. A thin lappet of lung is attached not infrequently to a mediastinal tumor which at times cannot be separated without tearing into the lung substance. It is better under these circumstances to divide the strip of lung attached to the tumor and then suture the divided surface of the lung airtightly and with regard to total hemostasis. The freeing of a tumor down to its point of origin or attachment should be done with the greatest care not only to prevent hemorrhage, but to prevent injury to important mediastinal structures. Not infrequently it is found that after freeing a tumor to its point of origin or attachment the tumor itself so completely fills the operative field that its final removal cannot be achieved under direct vision. This is true particularly in tumors at the apex of the thoracic cavity. In cases of this sort, a Shenstone snare, such as is used in controlling the hilum in pulmonary lobectomy, may temporarily be placed about the tumor at its point of attachment and the tumor removed, after which, under direct vision, the remaining fragment of tumor can be excised and hemorrhage controlled.

*Closure of the Wound.* The importance of meticulous aseptic technic during the course of operation and of careful closure of the thoracic wound after operation within the thorax has been completed cannot be overemphasized. The reopening of the wound, whether this be the result of careless closure or of infection, is a most serious and may well be a fatal postoperative complication.<sup>1</sup> An open sucking pneumothorax results, with its detrimental effects upon the respiration and circulation. Satisfactory reclosure is difficult and

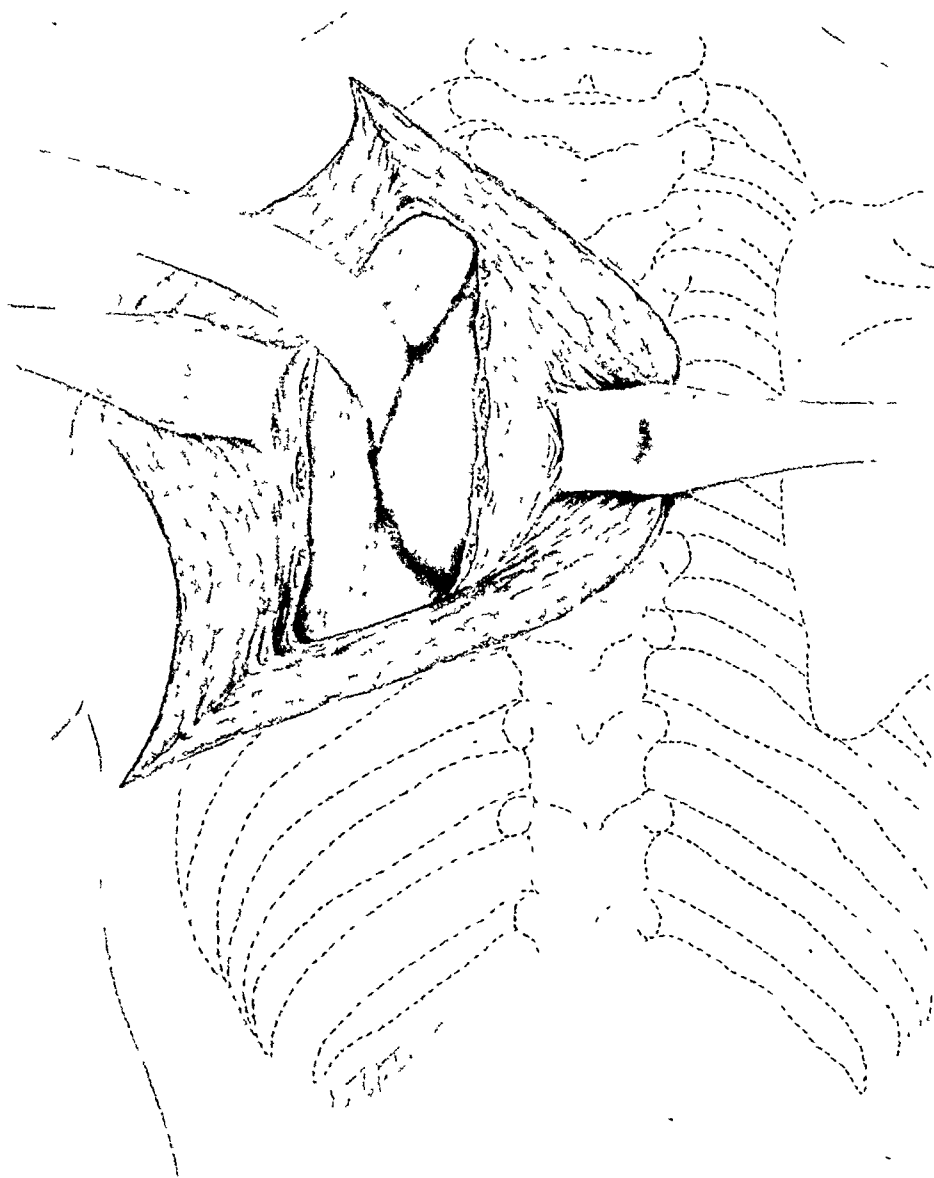


FIG. 3. Operative approach, posterior. (From Pack and Livingston's "Cancer and Allied Diseases," Paul B. Hoeber, Inc.)

oftentimes the problem presented is an unsurmountable one. Our own experience indicates that a careful closure of the wound in layers accurately approximated with interrupted sutures of silk is the best method. If ribs or costal cartilages are divided as is sometimes necessary in the anterior and lateral approaches, it is believed desirable to reapproximate the divided ends accurately with strong fine wire. The reason we prefer, in the lateral approach, the opening of the pleura by an incision through the posterior periosteum of a resected rib rather than by an intercostal incision is that the former offers better conditions for closure. If the incision has been made through the midline of the posterior periosteum, there is left on either side of it and attached to the intercostal muscles a strip of periosteum which holds firmly the silk sutures used in the airtight closure of the pleura.

The question of drainage of the pleural cavity arises when definite or suspected soiling has occurred in the course of the operation (dermoid cysts, etc.). Certainly drainage should not be used for bleeding at the end of the operation nor for anticipated pleural effusion which is common after operation within the thorax. These had best be treated by aspiration in the postoperative period. If, however, drainage is deemed necessary, it should never be established through the primary wound. To do so is to jeopardize the wound which may reopen with a resulting sucking pneumothorax. The best method we have found is to close the primary wound completely and establish airtight drainage of the pleural cavity at a distance from it by means of catheter introduced through a cannula.

There is little which needs to be said on the postoperative treatment. Supportive measures including blood transfusions may be necessary. An oxygen tent for the period immediately after operation is very desirable and is commonly used by us. The thorax is carefully watched by symptoms, physical examination and x-ray; and should a pleural effusion appear, the fluid is aspirated if it causes embarrassment. A pneumothorax, if not treated at the completion of the operation by aspiration and allowed to persist, tends to increase the likelihood of effusion and, therefore, had best be treated at the completion of the operation.

#### DERMOID CYSTS AND TERATOMAS

By far the commonest tumors of the mediastinum are the group designated as dermoids or teratomas. It is customary to include



under one or the other of these terms cysts or tumors of varying degrees of complexity, from the simple epidermoid cysts to those of more involved histologic composition. These tumors are congenital and probably have their origin from rests or misplacements of branchiogenic cells drawn into the thorax by the descent of the diaphragm and heart. Typically they arise in the anterior mediastinum and come to lie upon the anterior surface of the pericardium or in front of the great vessels, although they may assume other positions. In a number of the reported instances the tumor apparently arose from the thymus.

These tumors grow very slowly and usually remain quiescent for a number of years as indicated by the fact that only twelve, or 5.5 per cent of the 217 cases which we have collected were under twelve years of age. Symptoms appear rarely before puberty and the majority have not come under observation until the third decade. In some cases trauma or infection has been associated with an increase in the size of the tumor and the onset of symptoms.

In size these tumors vary from that of a walnut to that of a "man's head" or even larger. The largest reported tumors are those of Doran and Lester ( $30 \times 40 \times 20$  cm. and weighing 5320 Gm.) and of Stanbury and Oille ( $31 \times 18 \times 16$  cm., weighing 4173 Gm.). While they arise typically in the anterior mediastinum in front of the pericardium and great vessels, their location as disclosed by x-ray or at operation is variable. Duval classifies them as (a) retrosternal—not extending beyond the confines of the mediastinum, (b) cervico-retrosternal—presenting at the base of the neck, (c) mediastino-thoracic—extending into either thoracic cavity, and (d) lateral thoracic—lying largely in either thoracic cavity. The larger number of cysts causing symptoms are of the lateral thoracic variety.

The structure of dermoid cysts and teratomas varies greatly, the simplest being thin-walled cysts containing cloudy fluid or grumous material. Others contain ectodermal derivatives including skin, hair, teeth, etc., and the more complicated comprise tissues originating in all three germinal layers. Occasionally, a part of the cyst wall may undergo calcification and in a few cases the calcium deposits may be extensive. The solid teratomas are less frequently seen than the more simple cysts, and many of the former also contain cystic areas. A number of these tumors have been carefully studied and almost every variety of tissue found, while in others one tissue may overgrow the remainder, making the ultimate diagnosis difficult.

The most common complication of such tumors is infection resulting either from rupture of the cyst into a bronchus or from a respiratory infection. Such a complication may cause a sudden and rapid increase in the size of the tumor, provoking severe symptoms. The wall of the cyst becomes thickened and adherent to the surrounding structures while its contents may assume a thick, purulent character. Malignant degeneration either of a sarcomatous or carcinomatous nature may take place, but this is of relatively rare occurrence.

#### SYMPTOMATOLOGY

While a number of dermoid cysts and teratomas have been discovered accidentally or at postmortem in infants or young children, symptoms are rarely produced before the age of puberty. This latent period may extend far beyond adolescence, symptoms appearing only late in life. Indeed, in some cases the tumor remains completely asymptomatic and is discovered accidentally when the patient has reached an advanced age. The larger number, however, begin to produce symptoms when the patient is between 20 and 40 years of age, and so often after a respiratory infection that this may be considered to have initiated them. In others the symptoms of the tumor may be overshadowed by those of a coexisting pulmonary condition such as tuberculosis.

Pain, cough and dyspnea are the most common symptoms noted, and more rarely secondary symptoms from pressure on various mediastinal structures. In the occasional case in which cough is associated with expectoration of hair or other portions of the cyst's contents the diagnosis is evident. The physical signs are those to be expected from a mediastinal mass, and may in addition indicate certain of the effects of the tumor such as bronchial or mediastinal compression. If the cyst be infected, all these signs may, of course, be exaggerated.

The roentgenographic examination is of the greatest value in diagnosis and a spherical non-pulsating shadow in the anterior or superior mediastinum, or as more commonly seen, extending out into the lung field from this region, when taken with the clinical features often seen, makes the diagnosis almost certain. If bone or teeth are present in the cyst, they may be visible in the x-ray. When all other measures fail, aspiration of the tumor itself may be indicated and,

except when definite infection is present, would seem to be a relatively safe procedure. Even in the presence of infection it may not be contraindicated, provided the aspiration can be carried out through an area over which the pleurae are adherent. This procedure may yield brownish fluid containing epithelial cells from the simple cysts, grumous material or bits of hair from histologically more involved tumors.

When aspiration seems inadvisable or when the diagnosis is uncertain, exploratory operation may be required. This can be carried out easily and simple exploration should not be accompanied by any mortality in experienced hands.

Before considering treatment, however, a word should be said concerning the prognosis without operation. Such tumors have been discovered at autopsy or on routine physical examination without ever having caused symptoms, and in other cases have given rise to symptoms only late in life; in other words, the existence of intrathoracic dermoids or teratomas is not inconsistent with reasonable life for many years (forty-four years in one case). The advisability of surgery may, therefore, seem debatable in the asymptomatic cases; but these tumors, if untreated, give rise to symptoms so frequently, and complications such as rupture into a bronchus with infection of the cyst so often occur and add to the hazard and difficulty of surgery, that it seems wise to advise the extirpation of the cyst in all with the possible exception of the asymptomatic cases which can be examined at frequent intervals. Even in such cases, however, it is impossible to predict when complications such as rupture into a bronchus may occur.

The ideal procedure is complete extirpation of the cyst as this has given the highest percentage of cures and has been associated with the lowest mortality. Previous surveys of the results of surgical treatment are to be found in the paper of Aurousseau (*Rev. de Chir.* 62: 553, 635, 1924) and in our article in *Lewis' Practice of Surgery* (Vol. V, Chapter 5, p. 81). Since the latter was written, we have been able to collect seventy-five additional cases from the literature which, with seven recent cases of our own, bring the total to be considered here to 217 cases. Of these, thirty-two were discovered at autopsy, forty-seven patients died untreated, and in eight the treatment and results are unknown. The remaining 130 were subjected to operations of various sorts, the nature and results of which were as follows:

One patient, a child, was subjected to drainage of an empyema following what appears to have been a rupture of the cyst into the pleura and died during the operation. In two patients the cyst was exposed and was aspirated, with death in one case and failure to cure in the other. In five instances the cyst was found to be inoperable, three of which were due to malignant change. One patient died thirteen days after exploration, and while the remainder recovered from the operation, they succumbed to the disease. Simple drainage or marsupialization of the cyst was carried out in thirty-four cases with nine deaths. The remaining twenty-five patients recovered but only five were cured. Partial resection of the tumor was performed in twelve instances with two deaths and ten recoveries. Five patients were cured. Total excision has been the most widely employed procedure and has been followed by the lowest mortality and the highest percentage of cures. Thus in seventy-six cases, in which the tumor was completely removed there were but eight deaths, a mortality of 10.7 per cent, and all the remaining sixty-eight patients (89.3 per cent) were cured. This is to be contrasted with a mortality of 26.5 per cent and only 15 per cent cures in simple drainage of the cyst, and with the 16.6 per cent mortality and 41 per cent cures when the cyst was partially resected.

#### CASE REPORTS

E. S., (19993) N. Y. H. The patient was a 56 year old woman who first was admitted to the New York Hospital on November 15, 1920, at which time an adenoma of the thyroid was removed. Recovery was uneventful and the pathologic report indicated that the adenoma removed was in no way unusual.

On January 18, 1933, she was admitted complaining of extreme dyspnea and non-productive cough but no pain. Examination showed marked dyspnea on slight exertion, the chest dull to percussion on the right with bronchial breath sounds and a few rales. A roentgenogram of the chest showed displacement of the trachea to the left and a large, well-outlined tumor in the right upper lung.

On January 22, 1933, under local anesthesia, a thoracoplasty and exploration of the chest was performed and a tumor the size of a grapefruit was found. During manipulation the capsule of the cystic tumor was ruptured with the escape of a large quantity of chocolate-colored fluid. Because of the patient's condition, the removal was not attempted; the wound was packed with saline after the mass had been completely walled off from the pleural cavity. After a week the packs were removed and drainage

established. The marsupialized tumor mass sloughed out slowly and 2 months after operation only a very small piece of it remained which soon came away. From this time on the wound healed in and the patient regained her strength. Repeated roentgenograms showed only scarring and fibrosis in the region the tumor had occupied. Nine months after operation no signs of the tumor remained and the patient was without symptoms.

E. B., (97699) N. Y. H. This patient was an 11 year old colored girl who was admitted to the hospital for further study of a chest tumor which had been discovered during the course of a routine roentgenographic examination. She was without complaint of any nature.

Physical examination on admission was negative save for a circular area of flatness in the anterior chest extending from the sternum to about the midclavicular line. The heart was displaced slightly to the left. Roentgenographic examination revealed a shadow of smooth outline blending with that of the right side of the heart and extending out into the right pulmonary field. Oblique and lateral films showed this to be distinct from the heart shadow, however, and it was thought to arise from the chest wall.

One week after admission the tumor was removed through an incision along the right border of the sternum with the resection of one rib. The tumor lay in the anterior mediastinum, was attached to the pleura and to the pericardium and seemed to have its origin in a persistent thymus. It contained about 100 c.c. of thick, brownish fluid and microscopic examination of the cyst wall showed it to be a relatively simple teratoma.

Convalescence was uneventful save for a pleural effusion which disappeared within three weeks of operation. Three months later the patient was in good health and able to return to school. (Figs. 4 and 5.)

#### CYSTIC LYMPHANGIOMAS

Cystic lymphangiomas are occasionally found in the mediastinum, usually near the hilum or in connection with the pericardium. Some have attained great size. Excision was attempted by Michaelis but proved to be impossible and the patient died.

#### CILIATED EPITHELIAL CYSTS

Through the defects in the process of development of the esophagus and lower respiratory tract a series of anomalies may occur resulting in the production of cystic tumors. Thus, a bit of undifferentiated tissue may be pinched off in the process of separation of the esophagus from the trachea, and undergoing later growth, give rise to a cyst lined with ciliated epithelium along the course of the esophagus, particularly in its lower portion. The development



FIG. 4. N. Y. H. 19993, E. S. Dermoid cyst.  
(From Pack and Livingston's "Cancer and Allied Diseases," Paul B. Hoeber, Inc.)

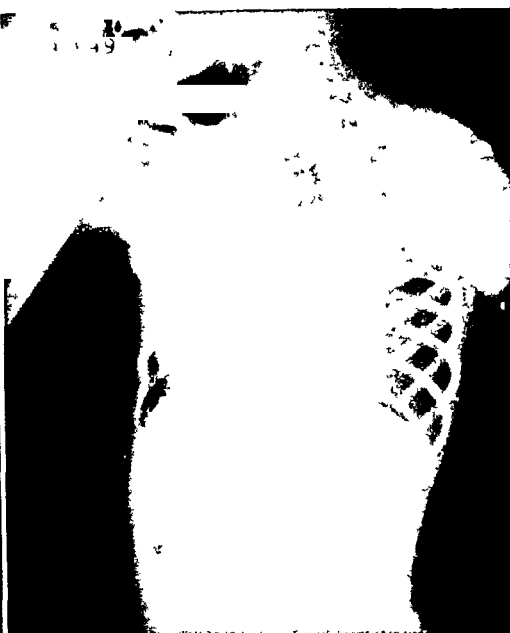


FIG. 5. N. Y. H. 97699, E. B. Teratoma.



FIG. 6. N. Y. H. 236674, P. K. Ciliated epithelial cyst, anteroposterior view.



FIG. 7. N. Y. H. 236674, P. K. Ciliated epithelial cyst, lateral view.

of the bronchi through a number of dichotomous divisions of the primitive trachea is a complicated process and, depending on the stage at which an aberrancy occurs, tracheal diverticulae, tracheal accessory lung, cysts of the respiratory epithelium in the mediastinum, accessory lobes of the lung or intrapulmonary cysts may arise. We are concerned here only with the third type of anomaly.

Cysts of respiratory epithelium in the mediastinum are located near the major bronchi, and while this is not always the case, tend to occur predominantly on the right side. Usually they present as rounded, thin-walled tumors projecting between the trachea and the vena cava or in this immediate neighborhood. Stilling has reported such a cyst of considerable size in the anterior mediastinum, and when in this location a derivation from the thymus is to be suspected.

The lining cells of the cysts are columnar or flattened and bear cilia. The remainder of the wall is derived from the mesenchyme and may contain fibrous tissue, cartilage, muscle or mucous glands. The contents consist of mucoid material containing desquamated cells and débris. No connection with the bronchi is demonstrable.

The number of intrathoracic cysts to be included in this category depends upon whether the group is confined to those contained in the mediastinum or is expanded to take in others located more laterally and arising within the lungs themselves. We have found in the literature twenty-five cases arising in the mediastinum and have encountered one ourselves. Many of the tumors were discovered at autopsy, and in only twelve instances was operation directed at the removal of the cyst. As this would indicate, many of these cysts fail to give rise to symptoms, but in others due to their origin close to the great vessels, symptoms from pressure on these structures or on the esophagus or air passages may be produced. Certain of the cysts have become infected and have caused serious or even fatal symptoms. Occasionally, as in our case, the x-ray picture of which is shown in Figure 6, the lesion was found when a chest film was taken in an attempt to explain why symptoms of a respiratory infection had not subsided after several weeks.

Differentiation from the more common dermoid cysts is not possible before operation, but is sometimes suggested when the x-ray shows a rounded mass presenting just above the hilum and particularly when lateral films show it to be located just anterior to the trachea.

While some of these cysts cause no symptoms, the tendency of many to increase in size and to compress the surrounding mediastinal and pulmonary structures, and the fact that some ultimately become infected with serious consequences, make operation advisable. In the twenty-five cases considered here, operation was undertaken in twelve, in eight of which the tumor was removed. In five of these patients the cyst was excised at the first operation and in three its removal followed preliminary drainage or marsupialization. Operation in the remaining four patients consisted either of drainage of the cyst or its partial removal. All the patients in whom complete removal of the cyst was possible recovered, one of them with a persistent bronchial fistula.

P. K., (236674) N. Y. H. The patient was a young man, aged 24 years, admitted to the New York Hospital June 6, 1939, complaining of stabbing pain in the chest over a period of three years. During the last three months these have occurred more frequently and have lasted longer. He had no dyspnea or cough. He had lost eighteen pounds in weight in three years.

Nothing noteworthy was found on physical examination except a slight bulging of the right dorsal chest, a scoliosis, limited excursion of the right diaphragm, slight dulness to percussion posteriorly and diminished breath sounds. Fluoroscopic examination showed a smooth, rounded mass to the right in the anterior mediastinum.

At operation on June 14, 1939, a mediastinal cyst was removed.

Recovery from operation was satisfactory and the patient left the hospital on the seventeenth postoperative day with the wound completely healed.

The pathologic report of the tumor was: cyst originating in a branchial rest. (Figs. 6, 7 and 8.)

#### ECHINOCOCCIC CYSTS

Echinococcic cysts occur in the mediastinum but would appear to be very rare. In the chest the disease most commonly occurs in the lung and occasionally in the pleural cavity. Rose's case, cited by Christian, is an example of echinococcic disease of the mediastinum. The patient, a woman aged 25 years, had a small lump just above her right breast for six years. When seen the mass measured three inches in diameter, was hemispherical, tense, elastic and fluctuating. It lay over the sternal ends of the second and third ribs beneath the pectoral muscle. At operation the external mass proved to be a cyst which communicated by an extension through the thoracic wall with a much larger cyst in the anterior mediastinum. From the latter



cyst both scolices and daughter cysts were obtained, confirming the diagnosis. The patient recovered and the wound healed. The case is an example of hour-glass cyst of the anterior mediastinum. Similar to it are the seven hour-glass echinococcic cysts of the posterior mediastinum described under hour-glass tumors of the spine. (Fig. 9.)

#### MEDIASTINAL FIBROMAS

So far as we can discover, thirty-two cases of this form of mediastinal tumor have been observed. The diagnosis of pure fibroma in all cases is not altogether clear, for the description of the lesions suggests in some instances invasive qualities as if they might be fibrosarcoma. In size they have varied from small tumors to lesions as large as a child's head and more often have occurred in the anterior mediastinum. In at least three cases, however, the tumors were located in the posterior mediastinum. Garré reported a case in which there were two tumors, one in the anterior mediastinum, the other and larger in the posterior mediastinum. The point of origin or attachment is not often accurately described but apparently they may arise from the pericardium, vertebrae and mediastinal surface of the sternum. In one case the tumor apparently was attached to the arch of the aorta. The most carefully described tumors are hard, firm growths on gross and microscopic section presenting the appearance of fibromas.

Symptoms in this group of cases have in the majority appeared rather late and after the age of forty years. Their duration has varied from a few months to five or more years. Pain in the chest, cough, with or without expectoration, and dyspnea have been the common symptoms. Hoarseness, enlargement of the anterior thoracic veins, difficulty in swallowing and pain and swelling of the arm have been noted. The physical signs also have been those common to mediastinal tumors. In two cases symptoms and signs were those of pulmonary tuberculosis, one of the patients spending two years in a tuberculosis sanatorium before a diagnosis of tumor was made.

The diagnosis of mediastinal tumor should not be difficult, for these tumors cast a well-defined shadow in the x-ray film. That the tumor is a fibroma may well be impossible to establish. The diagnosis usually has been made only by operation or at necropsy.

From the available data the prognosis is good if surgery is undertaken, hopeless if patients with fibroma are left untreated. In our earlier collected series of eighteen cases, thirteen patients were not

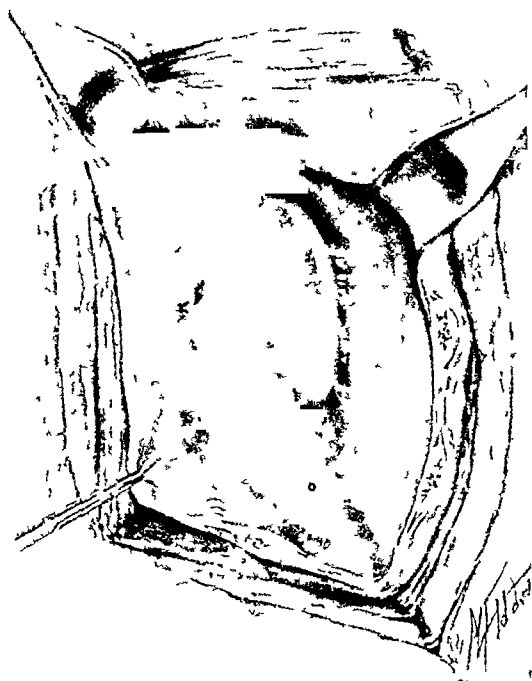


FIG. 8. N. Y. H. 236674, P. K. Ciliated epithelial cyst



FIG. 9. V. C. Echinococcal cyst.



FIG. 10. N. Y. H. 225066, A. C. Myxoma, anteroposterior view.

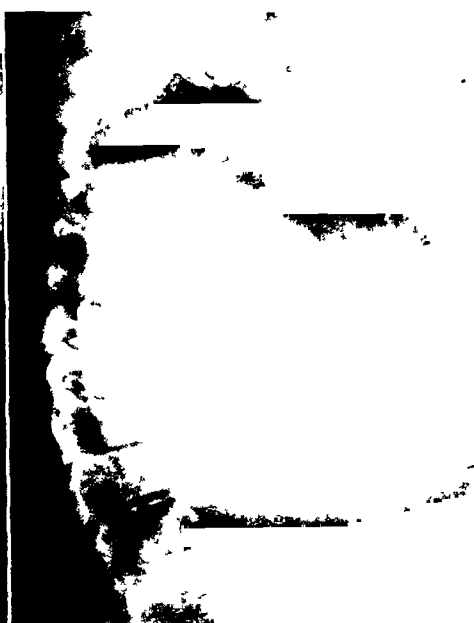


FIG. 11. N. Y. H. 225066, A. C. Myxoma, lateral view.

subjected to surgery and all died of the disease; five were subjected to operation with removal of the tumor and all recovered. In fourteen cases which have appeared in the literature since that time, nine patients were subjected to operation with removal of the tumor with eight recoveries and one death; while in five the tumor was found at autopsy. Of the entire series of thirty-two cases, therefore, fourteen patients were subjected to surgery with thirteen recoveries and one death; eighteen were not operated upon and all died.

#### FIBROLEIOMYOMAS AND MYXOMAS

In connection with the fibromas may be mentioned various modifications of this type of tumor which have occurred in our series and have been described in the literature under the terms of fibroleiomyoma, fibromyxoma and myxoma.

Jacobeus and Einar Key have described two cases of fibroleiomyoma of the posterior mediastinum. They occurred in patients 23 and 28 years of age who complained of pain in the chest, cough and shortness of breath. The x-ray in both cases showed a spherical circumscribed shadow in the posterior mediastinum. In both cases the tumor was successfully removed. In one the tumor was attached posteriorly to the periosteum of the fifth and sixth ribs, in the other to the vertebrae and ribs. Pathologically, the tumors are described as an edematous fibroleioma with shreds of smooth muscle running through it.

Evarts Graham describes a myxoma of the anterior mediastinum arising from the mediastinal pleura. An interesting feature of the case was the occurrence of an external, visible and palpable mass 4 × 4 cm. in size in the region of the right nipple. The x-ray of the chest showed in the midsection of the right lung field a large, dense, spherical shadow chiefly without and anterior to the thoracic wall. Exposure of the area at operation showed the tumor growing between the ribs. After resection of the two ribs it was found that the tumor was encapsulated and extended some distance beneath the sternum. The tumor was successfully removed. The pathologic diagnosis was myxoma of the pleura.

A huge myxoma arising in the posterior mediastinum and occupying almost the entire anterior hemithorax was successfully removed over a year ago by one of us (G. J. H.).

A. C., (225066) N. Y. H. This patient, a woman aged 41 years, entered the hospital complaining of fatigue, dyspnea and orthopnea of over six

months' duration, and of pain in the chest of six weeks' duration. She showed marked pigmentation of the face and body in the form of freckles and skin tumors of the fibroma molluscum type, warranting the diagnosis, in our opinion, of von Recklinghausen's disease. On examination she was obviously dyspneic and showed distention of the veins of the neck and upper thorax more marked on the right than left. The right thorax was flat on percussion from the second rib downward and posteriorly from the upper third of the scapula to the diaphragm. Breath sounds and voice sounds were absent over the area. The anteroposterior x-ray of the chest showed that the right half, with the exception of a narrow clear zone at the apex, was completely occupied by a dense circumscribed shadow. The lateral x-rays showed that the shadow occupied more than the posterior two-thirds of the right upper thorax. The exact nature of the tumor was not established but in view of the findings of von Recklinghausen's disease, a myxomatous type of tumor was suggested.

Operation was performed March 16, 1939. A lateral approach under intratracheal ether was made at the level of the sixth rib. On opening the pleura a firmly elastic tumor covered by a grayish white, opaque capsule was exposed. It was so huge that it was obvious the tumor could not be removed through the wound; this was immediately enlarged by dividing transversely and close to the transverse processes posteriorly the fifth, sixth, seventh and eighth ribs. Even with this large exposure it seemed impossible to free and deliver the tumor. An incision, therefore, was made through the capsule and there appeared a reddish, gelatinous tissue which could readily be stripped from the overlying capsule. Proceeding in this manner an enormous lobulated tumor mass eventually was cleanly delivered. It measured  $34 \times 29 \times 10$  cm. in diameter and weighed 3745 Gm. The capsule was then removed and found to be attached to the posterior mediastinum. The tumor grossly resembled the gelatinous, myxomatous tissue seen in the large external tumors of von Recklinghausen's disease (pachydermatoceles). The microscopic diagnosis was myxoma. The patient developed a mild intrapleural infection postoperatively which delayed her convalescence. She is perfectly well eighteen months after operation. (Figs. 10 and 11.)

#### XANTHOMA AND XANTHOSARCOMA

In a paper read before the American Surgical Association in 1923, one of us (G. J. H.) reported the successful removal of a xanthoma of the posterior mediastinum. At that time the only other case of intrathoracic xanthoma which could be found in the literature was the case of Wesson reported in the *Acta Chirurgica Scandinavica*, Stockholm, 53, 1921. Since then we have been able to collect eight

additional cases. It appears then that only ten cases of this tumor have been reported as occurring within the thorax.

In all cases reported these tumors have been observed in individuals between twenty-one and fifty years of age. The symptoms have varied but usually they have been the usual ones of pain in the chest, cough and dyspnea. Our case was unusual in that the patient, a physician, had no symptoms referable to his chest but had for fourteen years periodic, cramp-like pains in his right lower quadrant but without fever or nausea. His appendix had been removed without bringing relief. He was repeatedly examined without finding an explanation for his symptoms. During an attack of upper respiratory infection a routine x-ray plate of his chest showed a circumscribed spherical mass to the right of the cardiac shadow which a lateral plate showed to be in the posterior mediastinum. The removal of the tumor presented no difficulties and the patient has been well for many years. Pathologically, the tumor in gross section showed areas of yellow pigmentation like xanthomas elsewhere; microscopically, it showed xanthoma cells and groups of "foam" cells. (K., J. H. H. case.) (Figs. 12 and 13.)

The diagnosis of a circumscribed tumor in these cases can be made but the nature of the tumor has not, thus far, been established before operation.

All ten patients were subjected to surgery and the tumors successfully removed. There were no postoperative fatalities.

#### CHONDROMAS, ENCHONDROMAS, CHONDROMYXOMAS AND CHONDROMYXOSARCOMAS

These tumors have been reported under a variety of names as indicated. They have their origin in cartilage and may arise from the costal cartilage, sternum, costovertebral articulations and articular surfaces of intervertebral discs of the spine. In their growth they encroach upon the mediastinal space and compress its structures, and when large, may extend out into either thoracic cavity. Pathologically, they comprise two kinds of tumors: those which are solid and made up of cartilage (chondromas) and those (chondromyxomas) which are partly solid and partly cystic, the cystic portion consisting of ropy, sticky, clear or opalescent fluid or gelatinous myxomatous material. They present the characteristic of similar chondromas elsewhere, i.e., the tendency to recur or metastasize even though microscopically they are benign tumors. The determination of their



FIG. 12. K. Xanthoma, anteroposterior view.  
(From *Ann. Surg.*, 79: 670, 1924.)



FIG. 13. K. Xanthoma, lateral view. (From  
*Ann. Surg.*, 79: 670, 1924.)

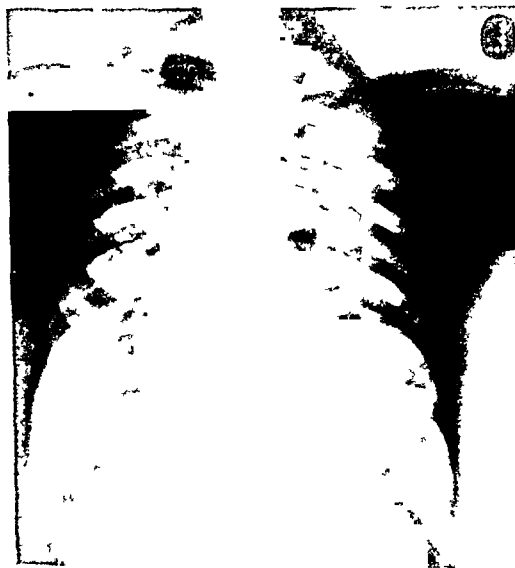


FIG. 14. N. Y. H. 24299, F. J. Enchondroma.



FIG. 15. N. Y. H. 24299, F. J. Enchondroma.

benignancy or malignancy, therefore, is not always possible from a pathologic study of the material. From the viewpoint of surgery they have these characteristics in common: that they are circumscribed, encapsulated tumors, which in their growth crowd the mediastinal structures to one side, do not as a rule invade them and rarely become firmly adherent to them. They lend themselves, therefore, to surgical removal and this should be comparatively simple if the tumor has not attained large size.

The chondromas involving the mediastinum are rather rare tumors. In our experience we have observed four, a chondromyxoma of the mediastinum arising from the costovertebral articulation, a chondroma of the spine with compression of the spinal cord, a chondroma of the sternum and a chondroma of the costal cartilages, both of which occupied the anterior mediastinum. Evarts Graham reports a case of chondroma of the vertebrae encroaching upon the posterior mediastinum which later was removed by George Muller of Philadelphia. In the literature on tumors of the sternum there are, with the exception of our case, but two or possibly three chondromas. In the literature of the so-called hour-glass tumors of the spine five are chondromas (one called chondrosarcoma) arising from the articular surfaces of the vertebrae, intervertebral discs or heads of the ribs. In the literature since 1926 we have found but fourteen cases implicating the mediastinum.

The tumors may grow to great size. Three of the four cases we have observed have been tumors as large or larger than a grapefruit. They may produce a deformity of the spine as gibbus, a visible swelling of the sternum or bulging of the chest wall. Symptoms usually have appeared in adult life. Pain is usually the first symptom and may be present for long periods of time before other symptoms appear. It may be localized behind the sternum, in the chest or in the back depending upon the location of the lesion. It may radiate in the course of the intercostal or other nerves. Cough and dyspnea may appear later and increase in severity as the tumor grows. A local or diffuse swelling of the sternum or thorax, or a deformity of the spine may develop. In a case of Garré a gibbus, pain and paresis of the legs, led to a diagnosis of tuberculous spondylitis. In a case of our own, pain in the right upper thorax, attacks of fever, cough and bloody expectoration led to the diagnosis of pulmonary tuberculosis and the patient spent six months in a sanatorium before an x-ray established the diagnosis of tumor. In two cases in Schlaepfer's series in which

the tumors had extended into the vertebral canal, paralysis of the extremities, as in spinal cord tumor was a prominent symptom. This was also true of the most recent case of chondroma we have had under observation. With the enlargement of the masses all the symptoms common to mediastinal compression may appear, i.e., suffusion or cyanosis of the face, dilatation of the vessels of the neck and upper thorax, hoarseness, difficulty in swallowing and edema of the extremities.

The physical examination need not be detailed for the findings resemble those in other mediastinal tumors. X-rays show a circumscribed, well-defined tumor shadow. A positive diagnosis of chondroma is, of course, difficult to make but is suggested in anterior tumors connected with the sternum and costal cartilages and in some of the tumors of the posterior mediastinum.

These tumors lend themselves to surgical removal and would appear to fail to respond to x-ray therapy. As we have noted, the tumors are circumscribed and can in our limited experience readily be freed from surrounding structures and removed. In all four cases observed by us the tumor was removed without great difficulty. Three patients recovered; one patient died shortly after operation with the symptoms of pulmonary embolism. Of the three patients who recovered, one developed metastases a year after operation from which she eventually died. The tumor in this case was diagnosed as a benign chondromyxoma. Of the fourteen cases found in the literature more recently, seven patients were subjected to operation with the removal of the tumor with five recoveries and two deaths; while seven were not subjected to operation and the lesion was found at autopsy.

F. J., (24299) N. Y. H. The patient was a 29 year old man who entered the hospital on March 17, 1933, with recurrence of a tumor removed in 1928 from his left anterior chest wall. The wound never completely healed. Two years after the first operation he noticed a similar growth on the right, which gradually grew, and eight months before admission an enlargement lateral to his original scar. There was apparently no pain or other symptoms from the presence of the tumor.

Physical examination showed the left side of the chest not as well developed as the right. There was a broad flat scar in the midclavicular line over the right costochondral junction, from which a crust could be lifted, leaving a moist surface. No sinus tract could be found. There was a lump on either side of the scar, irregular and hard. The larger one contained



a small amount of soft flocculent material. Roentgenograms showed an extensive tumor formation along the anterior chest wall on the right, near the midline in the region of the seventh, eighth and ninth costal cartilages with apparently no involvement of bony portions of the ribs or of the sternum or xiphoid process.

On March 22, 1933, thoracotomy was done and the tumor was found to be densely adherent to the pleura and at its upper margin to the lung. A large section of the anterior chest wall, including the tumor, the scar of the previous operation and portions of the fifth and sixth ribs, was removed. Microscopic examination revealed the tumor to be an enchondroma invading the bone upon which it abutted without evidence of malignancy.

Convalescence was complicated by hemothorax, empyema and infection of the wound but the patient was discharged in good condition and has been well since. (Figs. 14 and 15.)

#### MEDIASTINAL LIPOMAS

In a paper on the subject published in 1933, one of us (G. J. H.) described a mediastinal lipoma weighing approximately twelve and one-half pounds occurring in a young girl of 24. A search of the literature at that time showed that twenty-eight cases of intrathoracic lipoma previously had been reported. In the literature since 1933 we have found, including our own case, fourteen additional cases, bringing the total number at the present time up to forty-two. In forty of the forty-two cases the original articles were available to us; in two cases, those of Auvray cited by Garré and of Chiari cited by Gussenbauer, were not available.

A review of these cases shows that it is indeed difficult from the published case reports to make dogmatic statements regarding their exact origin. They have been described as subpleural lipomas, diaphragmatic lipomas, pericardial lipomas, bronchogenic lipomas and so on, depending upon the opinion of the reporter. Surveying the entire series one gains the impression that with one or two exceptions these tumors had their origin in the mediastinum and certainly occupied the mediastinum. They are here considered, therefore, as mediastinal lipomas. A further impression is gained that many of them are congenital tumors.

According to their location and form the lipomas may conveniently be divided into three groups: first, a group in which an intrathoracic tumor is continuous with an extrathoracic tumor giving rise to an hour-glass form; second, a group in which a mediastinal tumor

extends upward into the neck; and third, a group in which the tumor lies entirely within the thoracic cage.

1. *The Hour-Glass or Dumbbell Lipomas.* Of the forty-two cases, thirteen belong to this group. They are characterized by possessing two masses connected by a constricted portion or isthmus. The one mass lies within the mediastinum, the other lies external to the bony thorax and is visible and palpable. The constricted portion occupies a perforation in the thoracic wall, usually between the ribs. In size both external and internal portions of the tumor have varied greatly. The external tumor mass presents over the anterior, lateral or posterior aspects of the thorax and has been described as varying in size from that of a walnut to that of an adult head. The internal mass occupies some part of the mediastinum and has been described as large as an infant's head. The tumors have been found in children as early as six months of age and in adults up to sixty years of age. Because of their position within and without the thoracic cage, interesting speculations have arisen regarding their origin and development. The theory which to us appears most satisfactory is to consider the hour-glass type of lipoma as a congenital tumor appearing before the bony structures of the thorax have fully developed. The tumor, therefore, plays a passive role, being impinged upon and constricted during the development of the thorax in such a way as to form an extra and intrathoracic tumor. Analagous tumors elsewhere in the body (hour-glass tumors of the spine, hour-glass fibrolipomas in association with spina bifida occulta, intracranial and extracranial dermoids, etc.) support this theory.

2. *The superior mediastinal lipomas* presenting at the root of the neck. Of the forty-two cases, five belong to this group. The tumors apparently arise in the anterior mediastinum and extend upward, presenting as visible and palpable tumors, either directly above the manubrium or to one side of the substernal notch. They have, for the most part, been observed in adults. In size the tumors have varied up to a "quart cup."

3. *The Intrathoracic Lipomas.* Of the forty-two cases, twenty-four belong to this group. They are scattered through the literature from 1783 to the present time and often are incompletely recorded. In the majority the condition was not diagnosed during life and the tumor found at autopsy. In ten a diagnosis of intrathoracic tumor was made, but not a positive diagnosis of lipoma. In size the tumors vary greatly. In our case the tumor measured  $25 \times 25 \times 13$  cm. and

weighed twelve and one-half pounds; in Leopold's case the tumor weighed seventeen and one-half pounds. Other described tumors were small and probably did not provoke symptoms.

The clinical manifestations of the lipomas are, of course, dependent upon their form, size and location. The first and second groups described above present external tumors which are visible and palpable. Their internal or mediastinal portions cause compression symptoms or not depending on their size or particular location. This applies equally to the third group in which the tumor lies wholly within the mediastinum. Symptoms referable to the mediastinum are those common to all tumors. Pain in the chest, dyspnea, cyanosis, paroxysmal cough and choking spells all occur. A noteworthy finding is the long duration of symptoms indicative both of early origin and slow growth. A number of cases gave a history of definite dyspnea of from twelve to twenty years' duration, before coming under observation. Because of this slow growth and their soft consistency the lipomas may reach an enormous size and produce an astonishing degree of compression of the lungs and other intrathoracic structures; but because this takes place so gradually, symptoms may develop only very slowly. As noted, Leopold's case revealed at autopsy a tumor weighing seventeen and one-half pounds. The patient before death presented an astonishing degree of dyspnea and cyanosis in addition to ascites and edema of the abdominal wall, genitalia and legs.

A correct diagnosis of lipoma has been made but rarely and only in cases with external tumors. The long history of slowly increasing pressure symptoms may be suggestive. The study of the tumor shadow in two of our cases led to a guess as to the true nature of the lesion; for the characteristic feature of the shadow is that it becomes distinctly less opaque toward the periphery, suggesting a tissue more readily penetrable than the more compact tissue of fibromas or other tumors within the mediastinum.

Of the thirteen cases of hour-glass lipomas, twelve patients were subjected to operation; one was discovered at autopsy. In nine of the twelve patients operated upon, both the external and internal tumor were removed; in three cases only the external tumor was removed. Seven patients recovered and were cured and five died. Four of the five patients who died did so as a result of infection. They were all operated upon between 1856 and 1889 before aseptic surgery had been developed.

Of the five cases with tumors presenting at the root of the neck, three patients were subjected to operation, one was treated by x-ray and one was found at autopsy. In the three patients subjected to surgery the tumor was removed and the patients recovered. The patient subjected to x-ray therapy died.

Of the twenty-four cases of intrathoracic lipoma, sixteen patients died untreated with respect to their tumors which were discovered at autopsy. Eight patients were subjected to operation and the tumors removed, of whom five recovered and three died. It is to be noted that this summary of mediastinal lipomas covers a long period, a part of which antedates the x-ray and aseptic surgical technic. With our present facilities the lipomas should be a particularly favorable group from the viewpoint of surgical treatment.

F. E., (14732) N. Y. H. The patient was a 23 year old girl who entered the hospital on December 5, 1932, with a history of pains in the chest, shortness of breath and choking sensations of ten months' duration, beginning with a sharp pain and pressure symptoms in the left chest and intensified at the beginning of each menstrual period. Repeated aspirations which were performed at other hospitals where she went for observation failed to reveal the presence of fluid in the chest.

Physical examination showed a patient who was cyanotic and somewhat dyspneic; the trachea was shifted to the right. Expansion was limited in the lower anterior chest and absent in the left chest posteriorly. There was a marked bulge in the upper anterior thoracic wall. Left chest dullness on percussion was marked, the breath sounds were absent in the left axilla and left back, and numerous wet rales were heard at the right base; voice sounds were diminished over the left chest. The heart sounds were of good quality but rapid. An x-ray showed the trachea and heart displaced to the right and the entire left lung field obscured homogeneously.

After the patient had been gotten into the best possible condition, a thoracoplasty was done under local anesthesia; yellowish mucoid material was first aspirated from the tumor and then a section of the tumor tissue was taken for biopsy. This was diagnosed under microscopic examination as a lipoma.

On January 5, 1933, an attempt was made to remove the tumor surgically but while novocain was being injected into the intercostal space inferior to the sixth rib, the patient moaned and underwent tonic and clonic convulsions and, in spite of attempts to resuscitate her, she died within a few minutes.

Autopsy showed the tumor measuring 25 cm. both longitudinally and transversely at its widest diameters, occupying most of the chest cavity and apparently originating in the anterior mediastinum. Microscopic



FIG. 16. N. Y. H. 14732, F. E. Lipoma.  
(From *Ann. Surg.*, 98: 801, 1933.)



FIG. 17. N. Y. H. 14732, F. E. Lipoma.  
(From *Ann. Surg.*, 98: 801, 1933.)

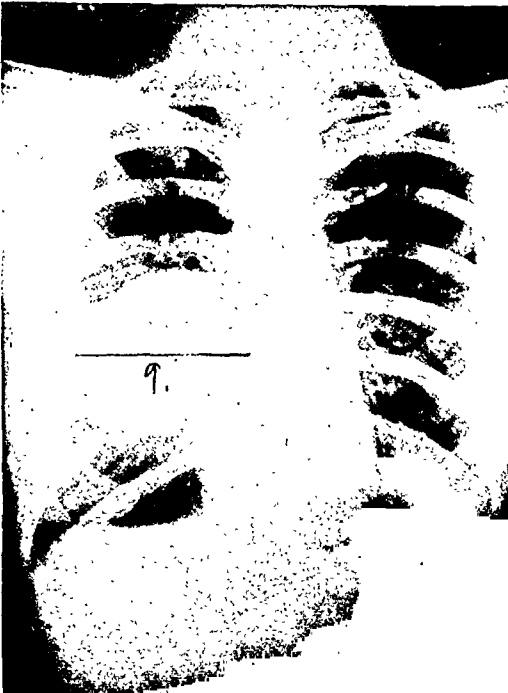


FIG. 18. N. Y. H. 137071, V. P. Liposarcoma.



FIG. 19. N. Y. H. 137071, V. P. Liposarcoma.

examination of the tissue showed the tumor to be a lipoma. (Figs. 16 and 17.)

V. P., (137071) N. Y. H. This patient, a woman of 27 years, was admitted on August 13, 1936, complaining of pain in her lower back. During a recent upper respiratory infection, her physician had made a diagnosis of thoracic tumor.

Physical examination showed nothing noteworthy except slight dulness to percussion over the posterior right chest. Breath sounds in the lower right axilla and at the base of the right lung were suppressed.

The patient was given an artificial pneumothorax and fluoroscopy showed a well-defined smooth rounded mass in the right chest. At operation a mediastinal tumor was removed. The patient did well after operation but developed a fistula which delayed her recovery. This has subsequently healed completely. The pathologic report of the tumor was liposarcoma. (Figs. 18 and 19.)

#### NEUROGENIC TUMORS

The mediastinum may be the site of a variety of tumors which have their origin in elements of the nervous system. Because the thorax contains nerves of both the somatic and autonomic systems, and in addition in the paravertebral ganglionic chain and in the cardiac and pulmonary plexuses, ganglion cells in profusion, all these elements must be considered in tracing the derivation of such tumors. The connective tissue elements of these structures should also be included in any complete survey of the precursors of the type cells of tumors of neurogenic origin.

In the embryo the autonomic ganglions are derived from the medulary epithelium by way of the neural or ganglionic crest cells which migrate outward to the sites of future ganglions and plexuses where they receive fibers from the spinal cord and brain stem and whence they, in turn, send out fibers to the various structures which they supply. In the course of this process the cells undergo a series of developmental changes from primitive undifferentiated cells through the cell types spoken of as sympathicoblasts (sympathigonia) and neuroblasts, to the adult type of sympathetic ganglion cell. The distance over which this migration takes place is so great as distinctly to favor faulty development resulting in "rests" of immature cells potentially capable of proliferation. The various steps in this maturation are set forth in Figure 20.

The intercostal nerves are composed of fibers of cells in the gray matter of the cord or in the ganglions of the posterior roots, both

derived from the medullary epithelium—the latter by way of the neural crest.

The sheaths of the peripheral nerves, three in number—the

DERIVATION OF TYPE CELLS OF TUMORS OF THE NERVES AND GANGLIA OF THE THORAX.

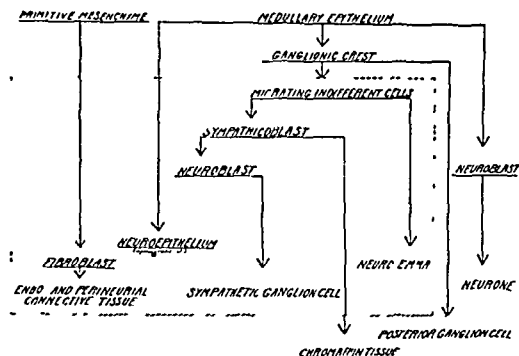


FIG. 20. Chart showing derivation of neurogenic tumors. (From *J. Thoracic Surg.*, 6: 381, 1937.)

myelin sheath, the sheath of Schwann and the connective tissue sheath—are of quite different anatomic origin and physiologic significance. The myelin sheath belongs properly to the axis cylinder and has a similar derivation. The sheath of Schwann, on the other hand, develops from the medullary epithelium by way of the ganglionic crest, while the connective tissue sheath (Henle's sheath) is of mesodermal origin and composes the endoneurium and perineurium.

The sympathicoblasts (sympathigonia) give rise not only to the cells of the sympathetic nervous system but also to the chromaffin tissue of the adrenal medulla, the carotid and coccygeal bodies and the "Gelbenzellen" of the intestinal tract.

These, then, are the precursors of type cells to be found normally as constituents of the adult nerve structures in the chest. As previously indicated, however, their process of development is extremely complicated; and one might expect that occasionally cells would be carried into the chest of a kind also derived from the medullary epithelium normally found only in the central nervous system, or its immediate outpouchings such as the retina. Only on such a hypothesis can we explain the presence in the chest of a tumor such as a neuroepithelioma composed of primitive spongioblasts.

The various elements of the ganglions are bound together by connective tissue and the nerve trunks themselves contain a considerable amount of fibrous tissue forming the endoneurium and perineurium. This tissue develops from the primitive mesenchyma

and may give rise here as elsewhere to any of the tumors of the fibroblastic series.

If one prepares a table such as appears in Figure 20, tracing the embryological derivation of the elements of the nervous structures within the chest, one finds that the dotted line encloses the type cells of practically all the neurogenic tumors occurring in the mediastinum, and that the higher the type cell lies in the chart, the more malignant is the tumor. Our own series contains examples of each type and comprises the more benign group including the ganglioneuromas, Schwannomas or neurinomas and the neurofibromas as well as the malignant tumors such as the neuroblastomas, sympathicoblastomas, neuroepitheliomas and neurogenic sarcomas. All these tumors have certain characteristics in common in that they arise most frequently in the posterior mediastinum, where, with the paravertebral ganglionic chain as well as the intercostal nerves, a considerable amount of nerve tissue is concentrated. Also, due to their frequent origin from the thoracic spinal nerves or ganglia, they may protrude into the spinal canal as well as into the chest, giving rise to the so-called hour-glass tumors. As these latter growths constitute a special group from the standpoint of symptoms, signs and treatment, they will be considered elsewhere; but it should be born in mind that any tumors arising from connective tissue or nervous elements in or near the intervertebral foramina may assume such configuration and that the group, therefore, constitutes an anatomic though not a pathologic entity.

The clinical picture in the benign tumors of neurogenic origin gives little or no indication as to the exact type of tumor present. Many of them remain asymptomatic and are picked up only in the course of routine x-rays of the chest; some begin to give symptoms during convalescence from a respiratory infection, while in others the symptoms are those of a complicating pulmonary infection. In others, definite symptoms are present early, most commonly beginning with pain or some other symptom of pressure on nerve structures such as a Horner's syndrome, hoarseness or an irritative cough. Large tumors may produce symptoms and signs of pressure on other mediastinal structures with dislocation of the trachea or compression of the larger bronchi. Perhaps because of their slow growth or because many are discovered before attaining great size, symptoms of severe mediastinal compression are not common with benign neurogenic tumors.



The x-ray examination reveals a shadow of even density and smooth curved outline located most commonly in the paravertebral gutter and in the upper part of the chest. Except on the basis of the relative frequency of the various types of tumors, no differential diagnosis is possible. With such a characteristic shadow, however, the likelihood that the tumor is benign is very good, although one must bear in mind that malignant tumors such as neurogenic sarcomas or fibrosarcomas or even primary bronchogenic carcinomas may present such a picture in the x-ray. Erosion of bony structures suggest malignancy, and this is particularly true when the transverse processes or bodies of the vertebrae are involved; but the benign fibromas, when they arise from the perineurium of intercostal nerves, may cause some pressure erosion of the ribs above and below their point of origin.

#### NEUROFIBROMA

The typical neurofibroma is seen in von Recklinghausen's disease and appears as a tumor arising from a nerve and containing any or all of the constituents of the nerve trunk. Such tumors are thought to originate primarily from the perineurial or endoneurial fibrous tissue and vary considerably in their composition. Thus, many are very largely fibrous or they may be a concomitant overgrowth of nerve fibers producing a mixed picture. In some the fibrous tissue may undergo degeneration with the production of myxomatous tissue or malignant changes may occur resulting in sarcoma. In the chest in by far the greater number of reported instances the tumor has been solitary, but in some the nerves of the thorax have shared in a typical widespread involvement of the peripheral nerves in the neurofibromatosis of von Recklinghausen's disease.

While no doubt some of the neurofibromas may have been diagnosed as pure fibroma, we have been able to collect from the literature twenty authentic instances of intrathoracic neurofibromas and add a case of our own. These tumors have been quite uniformly distributed among the various age groups and have been encountered in children less than ten years of age; six were found in patients over fifty. Seventy-seven per cent of the tumors occurred in females. While most of them have been of moderate size, some have reached enormous proportions—one measuring  $20 \times 15 \times 9.5$  cm. and weighing 170 Gm.

The symptoms, signs and x-ray findings are those of benign mediastinal tumor and are not distinctive for this particular variety of neoplasm. The true nature of the tumor is sometimes suggested,



FIG. 21. N. Y. H. 54442, H. O. Myxoneurofibroma. (From Pack and Livingston's "Cancer and Allied Diseases," Paul B. Hoeber, Inc.)

however, when it arises from one of the intercostal nerves near the spine, as in such circumstances some pressure erosion of the ribs immediately above and below the site or origin of the growth may be visible in the x-ray.

Four of the twenty-one cases were found at autopsy while seventeen patients were operated upon and the tumor removed. Five of these, or 29.4 per cent, died following operation but the remaining twelve (70.6 per cent) recovered.

An example of this type of tumor in our series was seen in a woman thirty-nine years of age:

H. O., (54442) N. Y. H. This patient was admitted to the hospital on February 7, 1934, complaining of frequent sudden attacks of bronchitis with unproductive cough over a period of ten years, and also periodic attacks of vertigo not associated with vomiting or loss of consciousness, during the past year. A typical Horner's syndrome on the right had developed during the past fifteen years.

The past history was not remarkable except for severe menorrhagia in 1931, at which time a diagnosis of fibroids of the uterus was made and radium therapy given, inducing artificial menopause.

Physical examination revealed signs of compression in the area of the right upper pulmonary lobe and x-rays of the chest showed a large solid

tumor occupying about three-fourths of the right upper chest, slightly displacing the trachea.

On May 3, 1934, the tumor was removed and found to be a myxoneurofibroma with no indication of malignancy. Convalescence was uneventful and the patient was discharged on the thirty-fifth day after operation with the wound healed but no change in the Horner's syndrome. Ten months after operation the patient wrote that she felt quite well except that she still had a slight tendency to bronchitis and slight dizziness. The pathologic report on the tumor was myxoneurofibroma. It apparently arose from the paravertebral sympathetic chain. (Fig. 21.)

#### GANGLIONEUROMA

This type of tumor which originates from the sympathetic ganglia has been identified with increasing frequency in recent years as more and more cases are being attacked. For a time it was felt to occur more frequently outside of the thorax, but we have been able to find sixty-eight instances of intrathoracic ganglioneuromas including one of our own.

These tumors arise in the upper part of the posterior mediastinum and lie upon the upper thoracic vertebrae and ribs. As they increase in size they extend laterally and when large, may completely fill the upper portion of the chest. In the reported cases the tumors have varied in size from  $5 \times 3 \times 1$  cm. to  $17 \times 12 \times 8$  cm. and in weight from 110 Gm. to 2 Kg. They are well encapsulated and of firm consistency, but in some a fairly dense outer shell has surrounded a mass of softer tissue. The cut surface is gray and glistening and appears to be relatively avascular with irregular lobulation. On microscopic section one sees typically rather coarsely arranged fibrous tissue intermingled with strands of medullated and non-medullated nerve fibers, the latter type being commonly the more numerous. Interspersed between these elements are seen multipolar ganglion cells varying in number in different tumors and many of them showing signs of degenerative changes such as vacuolization.

Particularly in recent years these tumors have been found more frequently in children. Thus, of the thirty-six patients in this series whose age is stated, 74 per cent were children under ten years of age. Females predominate in a ratio of 3:2.

True ganglioneuromas are benign but as they tend to increase in size they should be removed, preferably as soon as recognized. Furthermore, in the neurogenic tumors as a group, there may be relatively wide variations so far as their composition is concerned.

Some appear clinically and on gross examination to be benign and microscopically are found to contain a preponderance of immature or even embryonic cells.

In our collected series of sixty-eight cases, fourteen were found at autopsy or the patients died untreated, while fifty-one were subjected to operation. Of these sixteen or 31 per cent died while the remaining 69 per cent recovered. The majority of the operative fatalities have been due to shock or to hemorrhage occurring during the operation. This commonly results from tearing of mediastinal vessels in the process of freeing the tumor and can be avoided if the mediastinal attachment of the growth is freed last and after a braided silk snare is placed around its mesial aspect and used as a tourniquet. The growth can then be removed by cutting across distal to the snare and the blood vessels of the pedicle ligated in a dry field.

K. S., (182475) N. Y. H. A typical example of this group of tumors was encountered in a 3½ year old girl admitted to the Pediatric Service of the hospital for pneumonia and who was first suspected of having an intrathoracic tumor when a shadow in the upper portion of the right chest failed to clear up after the pneumonia had subsided. X-ray films then appeared as seen in Figure 22. Operation was undertaken and through a posterior approach with excision of portions of the third, fourth, fifth and sixth ribs, the tumor was exposed. The parietal pleura was reflected from the growth and after placing a snare about the mediastinal aspect, the capsule was incised just distal to the snare and the tumor removed. The vessels of the pedicle were then ligated and the wound in the chest wall closed without drainage. After operation it was noted that the child presented a Horner's syndrome on the right due, no doubt, to injury to the upper paravertebral sympathetic ganglia in the course of the operative procedure. (Figs. 22 and 23.)

#### NEURINOMA (SCHWANNOMA, LEMMOMA)

Tumors arising from the cells of the sheath of Schwann also have the gross characteristics of the fibromas, but present a different histologic picture. The Schwann cells are believed to be derived from the neural crest and are thus of ectodermal origin. They make up a specific stroma of the peripheral nerves and are considered by many to be analogous here to the true neuroglia of the central nervous system. The true neurinoma is seen as a nodular elongated enlargement of a nerve or as a rounded mass projecting from its trunk. Two types can be distinguished microscopically. One is made up of elongated fusiform cells often with many vacuoles which give a

foamy appearance to the cytoplasm and with their nuclei arranged side by side in "palisades." In this type also the cells may be arranged in whorls known as "Verocay bodies" and resemble those seen in meningiomas. The second or Antoni type of neurinoma shows considerable mucoid degeneration and may resemble a myxoma.

These tumors are much more frequently encountered in peripheral nerves and in the spinal canal than within the thorax. Indeed, in some of the nineteen intrathoracic cases which we have been able to find in the literature, the tumors were of the hour-glass variety comprising an intraspinal as well as an intrathoracic mass. There was no significant sex or age incidence among this series which would be of any aid in suggesting the specific type of neoplasm present, the diagnostic features being the same as those of other solid benign tumors such as the neurofibromas. Like these tumors they may vary considerably in size and are sometimes quite large. In one case the tumor measured  $20 \times 15 \times 14$  cm. and weighed 1700 Gm.

Four of the nineteen instances of this tumor were found at autopsy while fifteen patients were subjected to operation. In fourteen of the cases the tumors were successfully removed and the patients recovered, but the other patient died.

The malignant tumors composed of primitive elements of the nervous system are also encountered within the thorax as illustrated in the following case:

B. C., (94646) N. Y. H. The patient was a 9 year old Jewish boy who for fourteen months before admission had increasingly severe pains in the thoracic region of the spine.

Four days before admission the left leg became paralyzed; there was considerable generalized pain in both lower extremities.

Physical examination on admission was negative except for slight thoracolumbar kyphosis and chest findings which were: percussion note dull from the spine to the tip of the scapula and extending from the fourth to the seventh vertebra; breath sounds were suppressed under this region. X-rays showed a dense tumor mass extending chiefly to the left of the bodies of the sixth to ninth thoracic vertebrae. Slight extension of the tumor mass on the right also was evident. The mass was well-defined and made up of several layers. There was a slight scoliosis to the right in this region and some erosion of the left pedicle of the eighth segment.

By the fourth day after admission the signs of cord compression at about the level of the sixth dorsal vertebra had become clear. In spite of a rise in temperature for which no cause could be found, a laminectomy and partial resection of the cord tumor was performed—partial because collapse



FIG. 22. N. Y. H. 182475, K. S. Ganglioneuroma.

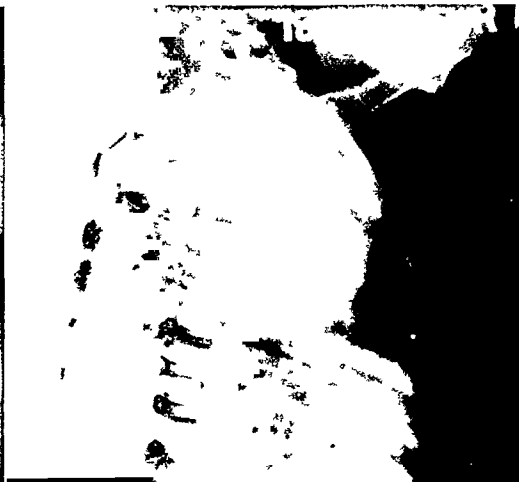


FIG. 23. N. Y. H. 182475, K. S. Ganglioneuroma.



FIG. 24. N. Y. H. 94646, B. C. Neuroblastoma.



FIG. 25. N. Y. H. 88739, M. B. Neurogenic fibrosarcoma. (From *Surg., Gynec. & Obst.*, 67: 577, 1938.)

of the patient made immediate withdrawal imperative. The tumor was found to lie between the sixth and ninth dorsal segments and to constrict the cord at the left of the eighth segment.

The postoperative course was progressively downhill. Despite transfusions and other supportive measures the patient died on the sixth day after operation.

Autopsy showed the tumor to be a neuroblastoma with extension into the posterior mediastinum and into the overlying pleura of the lung. (Fig. 24.)

#### TUMORS AT THE APEX OF THE CHEST (PANCOAST TUMOR, SUPERIOR SULCUS TUMOR)

*Pancoast first described the typical syndrome associated with certain tumors at the apex of the chest, consisting of unilateral pain in the shoulder girdle and upper extremity, Horner's syndrome, paresis of the hand and the presence of an abnormal roentgenographic apical shadow, and himself designated these growths as superior sulcus tumors. While the syndrome is definite and consistent, experience shows that it is not produced, as Pancoast inferred, by a special kind of tumor arising from structures other than the lung, pleura, ribs or mediastinum, but rather that any type of neoplasm occupying the mesial portion of the thoracic apex is capable of producing this symptom complex. It is, therefore, to be thought of as a geographical rather than a pathologic entity.*

The apex of the lung covered by the pleura protrudes through the narrow thoracic aperture bounded by the u-shaped first rib, the body of the first thoracic vertebra and the superior mediastinum and subclavian vessels and the eighth cervical and first thoracic nerves pass laterally over the arch of the pleura. The first and second intercostal nerves emerge just mesial to the apex and the upper ganglia of the thoracic sympathetic chain are in immediate proximity with the recurrent laryngeal and phrenic nerves just anterior. So many structures lie in this comparatively small space in the posteromesial portion of the apex that a small tumor may press upon several at once.

From the report of Ray, who has collected reports of more than fifty such cases from the literature and added five more from this clinic, it is evident that in the majority this symptom complex is caused by primary bronchogenic carcinoma which has invaded through the parietal pleura at the posteromesial portion of the apex.

Other tumors responsible have included neurogenic tumors, carcinomas arising in substernal goiters, carcinomas arising from bronchiogenic rests and pleural endotheliomas, as well as a variety of metastatic neoplasms.

The most important symptoms are those of pressure on nerves, and the first of these both in importance and in time of appearance is pain described variously as boring, gnawing, deep-seated or shooting and due to irritation of the first to the fourth thoracic nerves. This pain increases in severity until it becomes unbearable and requires large doses of opiates for its amelioration. In the early stages, signs of irritation of the sympathetic chain such as dilatation of the pupil or excessive sweating may precede the development of typical Horner's syndrome—ptosis and myosis and absence of sweating. The source and progress of the symptoms have been analyzed by Ray to whose paper the reader is referred for details.

The x-ray shows some abnormal shadow at the thoracic apex varying from a vague thickening of the mesial portion of the apex of the lung field to a more extensive involvement of the upper lobe. In many instances erosion of the transverse processes or bodies of the upper thoracic vertebrae is evident.

Except for the occasional benign tumor which produces the milder type of symptoms and which can be excised, the treatment of such cases is largely palliative. A number have been explored and biopsies taken, but such procedures have usually been followed by an increase of symptoms. The wisest treatment consists in section of the posterior roots of the nerves involved since this at least results in complete relief of pain.

M. B., (88739) N. Y. H. This patient, a physician 30 years of age, was admitted to the hospital in August, 1936, complaining of pains in his chest. He had had three unexplained attacks of right spontaneous pneumothorax over a period of five years. The initial pain was over the right scapula and subsequently in the right upper chest and inner side of the arm. There was disappearance of sweating on the right side of the body above the nipple line and right Horner's syndrome.

Operation revealed a stony hard tumor protruding through the space between the vertebral ends of the second and third ribs and invading the surrounding muscles.

A specimen was taken for biopsy and showed, on microscopic section, neurogenic fibrosarcoma. After operation the pain continued until death in February, 1937. The pathologic report of the biopsy specimen was neurogenic fibrosarcoma. (Fig. 25.)



## THE HOUR-GLASS TUMORS OF THE SPINE

The term, "hour-glass tumors of the spine," is used to designate a group of tumors which occur within a certain region and give rise to certain clinical manifestations. It does not imply a pathologic classification for the tumors are varied in kind. It is applied to tumors which arise along the spine from the highest cervical to the lower sacral vertebrae either from within the spinal canal, from the vertebrae or from without the spine. Arising intraspinally they extend outward through an intervertebral foramen or between two adjoining laminae to form a paravertebral tumor; or arising paravertebrally they extend through an intervertebral foramina into the spinal canal to form there an intraspinal growth. At the point where they penetrate the intervertebral foramina, the tumors are constricted and assume, therefore, an hour-glass shape. We are concerned here only with the tumors of this kind which, arising either intraspinally or paravertebrally, extend into the mediastinum.

Pathologically, these tumors vary in their nature. In a study made by one of us (G. J. H.) some years ago it was found that they were described as neurinomas, neurofibromas, neuromas, fibromas, ganglioneuromas, lipomas, chondromas, fibrosarcomas, spongioblastomas, neuroblastomas and leiomyomas. Grouping them according to their possible origin it appears that the hour-glass tumors may arise from the membranes, ganglia and nerve roots of the spinal cord, from the ligaments and fasciae in or about the vertebrae, from the cartilage of the articular surfaces of the vertebrae and ribs, from the intraspinal epidural fat and from the sympathetic nervous system. To these true tumors must be added a small group of echinococcic cysts which have occurred in this region. The great majority of the tumors thus far described have been benign encapsulated growths; a few have been definitely malignant.

In 1929 one of us (G. J. H.) found thirty cases reported in which the paravertebral portion of the tumor encroached upon the mediastinal space. Since then, cases have been reported from time to time but we have not made an effort completely to assemble them. The largest single series is that reported by Naffziger and Brown who in 1933 reported fifteen cases. Of these, five cases presented a paravertebral tumor extending into the mediastinum; a sixth case presented a large and presumably a tumor shadow which at autopsy proved to be an old tuberculous process unrelated to the hour-glass

tumor of the spine; and a seventh case presented a mediastinal mass which proved to be a carcinoma, probably originating in the lung. An interesting group of cases which was overlooked in our former paper are the echinococcic cysts of the spine, seven of which had the hour-glass form, caused compression symptoms with reference to the spinal cord and presented paravertebral extensions into the mediastinum. We have observed four cases ourselves: one a neurofibroma, one an unverified malignant tumor, one a chondroma and one a spongioblastoma.

The symptoms provoked by these tumors have been predominantly those of involvement of the spinal cord. Pain in the back and in the distribution of implicated spinal nerves, paresis or paralysis of the extremities and changes in sensation and reflexes have, in practically all cases, been the symptoms and clinical signs which have brought the patient to the doctor and have justified the diagnosis of extramedullary spinal cord tumor. Symptoms referable to the thorax such as pain, cough, dyspnea and cyanosis in the large tumors have been absent in the small paravertebral tumors. Physical signs such as dulness on percussion over the thorax are present and do not depend upon the size of the tumor. In the early cases (30) collected, these signs were present in four, stated to have been absent in sixteen and not mentioned in nine. In the same group of cases an x-ray of the chest positively demonstrated the mediastinal tumor in sixteen, and failed to show it in one case; in twelve cases there are no records of x-ray examinations. In three of our four cases the x-ray showed the tumor, in one failed to do so; but it is to be noted that only a single anteroposterior film was made. A lateral film would have demonstrated it.

It is apparent from the foregoing discussion that the diagnosis may be missed unless the occurrence of these tumors is borne in mind. A clinical manifestation being that of compression of the spinal cord, the diagnosis of cord tumor must certainly be made; but unless the mediastinal portion of the tumor is sufficiently large to cause symptoms and physical signs referable to the thorax, it may be overlooked. From the experience in the literature which our own experience confirms, anteroposterior or lateral x-ray films of the chest in cases of spinal cord tumor, will serve to visualize the mediastinal portion of the hour-glass tumors, and this additional examination is recommended.

In the thirty cases of hour-glass tumors we have referred to, operation was undertaken in twenty-six. In seventeen cases the intraspinal and mediastinal parts of the tumor were removed at one sitting through a laminectomy approach, the mediastinal tumor being exposed by the resection of the transverse processes of the spine and, if necessary, the adjacent ribs; in one patient the intraspinal and mediastinal parts of the tumor were removed but at two sittings; in four patients the intraspinal tumor was removed but not the mediastinal; in three patients the mediastinal tumor was removed but not the intraspinal (in one the cord tumor was not found and the patient later died; in two, symptoms were not sufficiently severe to warrant exploration—outcome unknown); in one case the mediastinal tumor was explored but, because of vascularity, was not removed. In this last case treatment was with radium which caused the disappearance of the cord symptoms but not the disappearance of the mediastinal tumor; but there was freedom from symptoms for five years. There were seven deaths in 26 patients, a rather high mortality; but it is to be remembered that some of the patients were operated upon a good many years ago. Of our four cases, in one an operation was not performed due to the poor condition of the patient; in two patients the intraspinal and mediastinal tumors were removed at one sitting; in one (spongioblastoma) a part of the intraspinal tumor only was removed. This case was given 2000 R units through the open wound while the patient was on the operating table. She is free from all symptoms two and one-half years after operation. Naffziger's seven patients were subjected to operation. In one the intraspinal and mediastinal tumors were removed with recovery; in one the intraspinal tumor was removed, the mediastinal tumor partially removed with recovery; in two the intraspinal tumor was removed, the mediastinal tumor was not removed with one recovery and one death; and in three patients the intraspinal tumor was partially removed, the mediastinal tumor not removed with one recovery and two deaths.

Of the seven cases of hour-glass echinococcic cysts, five patients died with symptoms of spinal cord compression without having been subjected to surgery and came to autopsy. In all there presented an echinococcic cyst compressing the spinal cord connected with a paravertebral cyst lying in the mediastinum. Two patients were subjected to operation with one recovery and one death. From the

experience thus far gained, surgery would appear the treatment of choice; especially in view of the fact that the large majority of the tumors are benign and not likely favorably to be influenced by x-ray therapy. In carrying out surgical procedures, the primary approach should be directed to the removal of the tumor compressing the spinal cord not only because of the urgency of the cord symptoms but because of the possibility of removing through the primary incision and at the same time the paravertebral tumor.

M. Y., (180675) N. Y. H. This woman, aged 64 years, was admitted to the hospital on October 16, 1937, complaining of pains in the left chest for 5 or 6 weeks. She also had difficulty with micturition and evacuation of her bowels. Her legs were almost entirely paralyzed.

Physical examination showed a slight hypertensive cardiovascular disturbance and evidence of cord compression at the fifth and sixth dorsal vertebrae.

A laminectomy was performed under local anesthesia on October 2, 1937, and portions of an infiltrating, extradural tumor mass removed from around the cord. The dura was not opened. X-ray therapy was instituted on the operating table through the open wound and later at frequent intervals.

The neurogenic symptoms disappeared and the tumor was seen on x-ray to have almost completely vanished.

Two years after operation the patient was in good condition without recurring neurogenic symptoms. The pathologic report of the tumor was glioblastoma multiforme. (Fig. 26.)

#### TUMORS OF THE THYMUS GLAND

In the present paper we shall omit consideration of the thymic hyperplasias as expressed by enlarged thymus and persistent thymus, as described in association with so-called status lymphaticus and as observed in exophthalmic goiter, and confine ourselves only to the tumors of the thymus gland.

A review of the literature shows the difficulty of presenting very clearly and simply a pathologic classification of the thymic tumors. Without attempting to discuss their pathology, which would take us beyond the scope of this paper, we present as a working classification that of Foot taken from a recent publication. It is more complicated than the earlier classification of Ewing but only in so far that it includes additional groups of tumors.

## NON-MALIGNANT THYMOMAS

Aside from thymic rests, either *in situ* or ectopic, and of the choristoma variety, there are reports of tumors composed of disarranged though otherwise practically normal thymic tissue. The thymic reticulum cells tend to lie peripherally, the thymocytes centrally in the lobules, reversing the normal situs. Thymic corpuscles are usually present and have the characteristic appearance. The eosinophilic thymic cells are apparently somewhat in eclipse in these tumors, although a careful search may reveal their presence.

## MALIGNANT THYMOMAS

1. *Thymocytic or Lymphocytic Type.* These are composed of small, round cells with deeply staining nuclei. Ewing believes that they are darker than lymphocytes. Hassall's corpuscles may or may not be present.

2. *Large-Celled or Lymphoblastic Type.* These are made up of large, rounded, ovoid cells resembling lymphoblasts or primitive thymic reticulum cells. Thymic corpuscles may or may not be found.

3. *Thymic Reticulum Cell Type.* The cell of this small group closely resembles the entodermal thymic reticulum cell, and the group is probably the largest and most frequently occurring of the malignant thymomas. It has been reported in man as well as in several animals, notably the chicken, cow, horse and sheep. Feldman states that the cow seems to be most frequently affected. The cells for these tumors are more pleiomorphic ranging from spheroidal to spindle-shaped, or multipolar and stellate. They may often form duct-like structures that are so definitely epithelial in their appearance that Schminke included these tumors in his new group of "lymphoepitheliomas." Thymic corpuscles are variably present.

4. *Perithelial Type.* This had been reported by Symmers in eight of his twenty-five cases, and by Matras and Priesel (Case 5) and Laas, although the foreign authors do not refer to it as such. It shows definitely perithelial arrangement of radially directed fusiform cells about its vessels (be it noted, without interpolated areas of necrosis) and is quite characteristic in appearance. Thymic corpuscles do not play an important role in this tumor.

5. *Granulomatous Type.* Symmers has collected five cases of Hodgkin's granuloma in the thymus. There may be others in the literature reported in connection with Hodgkin's disease and, there-



FIG. 26. N. Y. H. 180674, M. Y. Glioblastoma multiforme.



FIG. 27. N. Y. H. 147070, T. M. Thymoma. (From Pack and Livingston's "Cancer and Allied Diseases," [Paul B. Hoeber, Inc.]



FIG. 28. N. Y. H. 45318, N. G. Hodgkin's granuloma. (From Pack and Livingston's "Cancer and Allied Diseases," Paul B. Hoeber, Inc.)



FIG. 29. N. Y. H. 45318, N. G. Hodgkin's granuloma. (From Pack and Livingston's "Cancer and Allied Diseases," Paul B. Hoeber, Inc.)

fore, missed in our review. The picture is that of Hodgkin's granuloma located in the thymus or at its site.

6. *Epithelial or Carcinomatous Type*. These are tumors of elderly subjects and resemble epidermoid carcinoma as they are composed of innumerable thymic corpuscles in all stages of development and degeneration, thus creating a "pearly" appearance. The thymic reticulum cells may form radiating cords from such pearls, which sometimes have duct-like arrangement, and, with a liberal admixture of lymphocytoid elements, may shift the picture toward that of the "lymphoepithelioma" of Schminke.

7. *Teratoid Type*. Here all the elements of the normal thymus are found to be undergoing abnormal proliferation, and they are often thoroughly disguised. The proliferation may be distributed through all the elements, or it may preponderate in one or two. In addition to quasi-normal components, duct or gland-like structures may be found, or even solid medullary plugs of pale, rather delicate epithelium. These tumors seem to be more frequent in young individuals. Margolis suggests that ducts of this sort might be found in normal thymus and indicate the presence of rests that might later give rise to tumors of this sort. His reported tumor was quite rich in such structures, which were less prominent though present in a case by Foot and Harrington.

#### BENIGN OR NON-MALIGNANT THYMOMAS

The benign tumors of the thymus, judging from the reports in the literature, occur less commonly than the malignant tumors. As they have been described, they have been associated with myasthenia gravis in some cases, not associated with this condition in other cases. Due, probably, to their relationship with an interesting disease, the tumors associated with myasthenia gravis have been more carefully collected and we shall speak of them first.

*Thymic Tumors in Myasthenia Gravis*. In 1901, Weigert reported a case of myasthenia gravis with a thymic tumor and numerous foci of lymphocytes in the skeletal muscles. Bell described a case in 1917 and collected the cases from the literature. He found that between 1901 and 1917, fifty-seven patients, dying with the symptoms of myasthenia gravis, had been subjected to autopsy; and that of the fifty-seven patients, the thymus was enlarged in seventeen, and contained a tumor in eleven. In one half of the cases, therefore, either an enlargement of the thymus or tumor was found. Blalock et

al., in 1939, reported a case of myasthenia gravis with an intrathoracic shadow which, at operation, proved to be a cystic tumor in the position of the thymus, the successful removal of which has been followed by disappearance of the symptoms of myasthenia gravis. He and his coauthors collected twenty-six additional cases (including their own) in which myasthenia gravis was associated with a lesion of the thymus. Of the total fifty-four cases in which a lesion of the thymus has been associated with myasthenia gravis, a tumor has been present in thirty-two, an enlargement or persistent thymus in twenty-two.

These tumors have shown various pathologic pictures. The tumor in Bell's case is described as occupying the position of the thymus, measured  $6 \times 4 \times 3.5$  cm. and weighed 60 Gm. It was definitely encapsulated. The cut surface was soft in consistency, light gray in color and showed many hemorrhagic areas. Microscopic section showed a tumor tissue composed of cells with large vesicular nuclei and abundant light-staining cytoplasm, the whole fused together to form a syncytium. Throughout it were numerous spaces of variable size and shape containing small lymphocytes. No Hassall's corpuscles were seen. The tumor is called a benign thymoma suggestive of an adenoma. Of the cases in the literature at least five resemble Bell's case. Bell is of the opinion that the tumors in myasthenia gravis form a distinct group of comparatively small benign growths composed of young thymic tissue. Norris considers that the pathologic changes in the thymus are of the nature of a hyperplasia, which, when extreme, may give rise to an encapsulated tumor mass. Of the tumors reported in association with myasthenia gravis, all except one appear to be benign; the exception is Meggendorfer's case reported in 1908, which is called a large-cell sarcoma and which in its growth, extension and metastases, presented the characteristics of the malignant thymoma.

In addition to the benign tumors seen in myasthenia gravis are others which are not associated with this disease. These are fewer in number. There is no evidence which we can find that pathologically they are essentially different from the tumors seen in myasthenia gravis. An example of the largest tumor of this sort thus far reported, is one successfully removed by one of us (W. DeW. A.). A brief abstract of this case will follow.

Clinically we must again differentiate the tumors with and without the signs and symptoms of myasthenia gravis. In the former



group and because of the finding of lesions of the thymus in one-half of the autopsied cases of myasthenia gravis, the clinical manifestations of this disease should suggest the possible presence of a thymic tumor. The tumors themselves have been small, only two having been reported as large tumors, and, therefore, not likely to give rise to mediastinal compression symptoms. The x-rays reported show spherical circumscribed shadows in the anterior mediastinum immediately behind the sternum and in contact with the superior part of the pericardium.

In the tumors not associated with myasthenia gravis the clinical manifestations depend more or less upon the size of the lesion. In the small tumors, symptoms may be mild or absent, in the larger tumors they may be severe. A good example of the large benign tumor is the case just referred to.

T. M., (147070). A school boy, 13 years of age, was admitted to the New York Hospital October 14, 1936, suffering from dyspnea, orthopnea and weakness of seven months' duration. He had been well up to the age of 7 when he had scarlet fever, and following this measles and chicken pox. Since then he had been frail; at the age of 9 he was fluoroscoped by his family physician who told his parents that he had "thymic gland trouble." He became easily fatigued, and became short of breath on exertion. He had only a slight cough without expectoration or hemoptysis. During some seven months prior to admission his symptoms increased particularly the dyspnea and orthopnea. The latter was most marked at night so that he slept propped up in bed. There had not been any pain in the chest.

Examination showed the trachea displaced to the right, the left half of the chest full and with restricted respiratory movements. The cardiac and superior mediastinal dullness were displaced to the right. The heart sounds were best heard in the fourth and fifth interspaces to the right of the sternum. The left lung field was entirely flat on percussion below the first rib anteriorly and below the spine of the scapula posteriorly. Over the area of flatness the breath sounds were absent. The diaphragm seemed to be displaced downwards. X-rays of the chest showed a huge mass occupying the entire left hemithorax except at the extreme apex and base, dislocating the heart and mediastinal structures to the right. The central portion of the shadow was denser than the peripheral. Two aspiration biopsies failed to yield sufficient tissue for study although a few large cells and lymphocytes suggesting thymic tissue were noted. The diagnosis was not positively established. The great size of the tumor with the late development of compression symptoms suggested a slow growing soft tumor like a lipoma and it was with this diagnosis that operation was undertaken.

The operation was performed November 6, 1936, under intratracheal anesthesia, and the entire tumor successfully removed. The tumor was a large, encapsulated, yellowish-white, lobulated growth weighing 2235 Gm. and measuring  $26 \times 24 \times 7.5$  cm. in its various diameters. On microscopic section the tumor was found to be made up of islands of thymoid tissue surrounded by adipose tissue. The tissue making up the scattered islands approached normal thymus. There were small thymocytes in abundance, thymic reticulum cells, and thymic corpuscles in every stage of development and involution. A diagnosis of benign thymoma was made. The boy has been perfectly well since operation. (Fig. 27.)

There are but few cases of benign tumor of the thymus in which a surgical attack has been undertaken. Alder reported a case of myasthenia gravis in which a benign thymic tumor, the size of a child's head, was removed by Sauerbruch. The patient died eight days after operation from mediastinitis. Obeditzsch reported a case in which a tumor, the size of a man's fist, was removed by Sauerbruch, the patient dying five days later from a streptococcic infection. The case we have just described is the first, so far as we can discover, in which a benign thymic tumor has successfully been removed. Blalock's case is the second successful surgical attempt. The association in his case of myasthenia gravis and the disappearance of the symptoms of this disease following the removal of the tumor adds to the evidence of a relationship between the two conditions, but is not, of course, conclusive.

#### MALIGNANT THYMOMAS

Rubashow, in 1911, reported a case and collected sixty-nine cases of malignant thymoma from the literature. They included thirty-three cases collected by Hoffman up to 1896. Among them were fifty-two sarcomas, twelve carcinomas and seven miscellaneous tumors. Foot, in 1926, reported four cases, reviewed the literature and found that, if the miscellaneous cases of Rubashow are excluded, there were eighty-one cases of primary malignant thymic tumors reported. Crosby, in 1932, again reviewed the subject and found 166 cases, 122 of which he classified as sarcoma and forty-four as carcinoma. Decker, in 1935, brought the number to 208. Since 1935 we have found nineteen additional cases and have observed two of our own bringing the number to 230.

Pathologically, the tumors include the lymphosarcomas, the most frequent variety, the carcinomas and the sarcomas arising pre-

sumably from the connective tissue stroma of the thymus. To these are to be added the granulomatous tumors as Hodgkin's disease, the teratoid tumors or carcinosarcomas and other variously described malignant conditions. Generally speaking their growth within the mediastinum is somewhat similar. The tumors occupy the anterior mediastinum. Anteriorly they may, in their growth, exert pressure upon and cause protrusion of the sternum and even perforate the bone. Posteriorly the tumors sooner or later surround the trachea, bronchi, pericardium and great vessels, and at times also the esophagus. They vary in size but in the majority of instances they have at autopsy pretty well filled the mediastinum. They are commonly hard nodular or lobulated tumors, but the rapidly growing tumors may be soft, vascular and hemorrhagic. Encapsulation within the mediastinum has been observed but the more malignant forms become adherent to the surrounding organs and invade the pleura, lung and pericardium, large vessels and trachea. Metastases to distant organs have not been common but occasionally metastases in the liver, spleen, adrenal, pancreas and kidney have been observed.

The age of onset has been variable. The teratoid type of tumors have occurred early in life and the majority of sarcomas appear in young people. The carcinomas occur later and in the majority of cases in individuals over fifty years of age. The symptoms may be chiefly or entirely thoracic and due to mediastinal compression. Pain in the chest, cough and dyspnea are the common symptoms which increase gradually or rapidly. Engorgement of the veins of the neck and upper thorax, hoarseness, difficulty in swallowing and eventually edema of the extremities may appear. A pleural effusion may occur; fever, loss in weight and strength and anemia may supervene. While the thoracic symptoms predominate, there usually occurs before death some external evidence of the mediastinal tumor as fullness in the suprasternal notch or enlargement of the glands of the neck or axilla. In some cases external evidence of the disease may antedate thoracic symptoms, i.e., swelling of the neck, a tumor which perforates the sternum or thoracic wall or enlargement of the glands of the neck. In these cases symptoms referable to the chest appear sooner or later and gradually or rapidly progress. Death due to suffocation is the common termination. The clinical course has usually been rapid and death may occur in two or three months after the patient comes under observation. One of Ewing's patients, however, lived two years.

The physical findings need not be detailed. Since the tumor occupies a central position in the anterior mediastinum there is dullness behind and to either side of the sternum. The signs of pleural effusion may be present at either base. The x-ray shows a shadow occupying the upper mediastinum extending a variable distance downward from the sternal notch and laterally beyond the margins of the sternum. The diagnosis of primary thymic tumor has apparently rarely been made before death although the presence of a mediastinal tumor is of course evident. In a few cases partial excision of an external tumor has led either to a correct diagnosis or at least to a diagnosis of lymphosarcoma. The treatment has been unsatisfactory. We have found some eight recent cases in which surgery was undertaken with a fatal outcome in each, and from our own experience and autopsy reports it is evident that removal would be possible only in the very early stages of the disease. From the reports in the literature, radiotherapy also has not been very successful; and we thus far have failed to find a case in which improvement over any considerable period has occurred.

LYMPHOMA, LYMPHOCYTOMA, LYMPHOSARCOMA, HODGKIN'S  
DISEASE

There still remains a good deal of confusion regarding the various conditions arising from lymphoid tissues; and although we have again attempted a survey of the literature we are not able to present definitely the frequency, origin and pathologic picture of the various lesions arising from the mediastinal lymph glands. Baldrige and Awe classify the lymphomatous tissues pathologically, recognizing a sclerosing type as Hodgkin's disease, an endothelial type as in lympho-epithelioma, a lymphoblastic type as in lymphosarcoma, and a lymphocytic type with and without leukemia. Ewing classifies the tumors according to their origin from the three anatomic elements in lymphoid tissue capable of originating lymphoid tumors, i.e., lymphocytes, reticulum cells of follicles and pulp and endothelial cells of pulp and cavernous sinuses. From the lymphocytes may originate the simple lymphomas, the malignant lymphocytomas and the leukemias; from the reticulum cells, myeloid leukemia, malignant granuloma, Hodgkin's disease and large cell lymphosarcoma and from the endothelial cells, the endotheliomas. To attempt to place the tumors of the mediastinal lymph nodes described in the literature in either of these classifications is, as we have noted, a difficult and

profitless task. We shall confine ourselves, therefore, to a limited discussion of these lesions, emphasizing those which in our experience are more commonly observed.

#### SIMPLE LYMPHOMA

This benign tumor as occurring in the neck, axilla and groin must be rare in the mediastinum and we have not, thus far, found a certified case described.

#### MALIGNANT LYMPHOCYTOMA

In this group may be included the malignant lymphocytomas, not otherwise designated, the malignant lymph-adenomas and possibly the small-celled tumors of the thymus associated with lymphatic leukemia. This is a clinical rather than a strictly pathologic grouping but is made necessary by the paucity of details in the pathologic descriptions. The pathologic basis for the group is the predominance in the mediastinal tumors of small cells resembling lymphocytes; but whether these small cells are derived from lymph nodes or thymus is not often clearly stated.

The tumors arise as a rule in the anterior mediastinum, often in the general location of the thymus. They vary in size from moderate to large tumors spreading upwards to the neck and downward to or over the pericardium. They may fill the space between the sternum and spine and encroach laterally upon the lungs; and they show a tendency, like the malignant thymomas and lymphosarcomas, to surround the trachea, great vessels and esophagus which, although constricted by the tumor, may not be directly involved for a considerable period. The tumors by extension may invade the pleura, lung, pericardium and glands of the neck and axilla and may metastasize to the lungs, liver, spleen and other organs. They consist of a single or lobulated mass, white or slightly yellowish or grayish-white on section, which presents a uniform surface marked by strands of connective tissue. In a few cases, areas of necrosis have been described. Microscopically, the picture has varied, resembling in general that of a sarcoma with the predominant cells of the small lymphocyte type.

#### LYMPHOSARCOMA

This must be considered one of the common malignant mediastinal tumors. In a series of 145 cases of mediastinal tumor seen in the

Medical and Surgical Wards of the New York Hospital, forty-seven or 32 per cent are diagnosed as primary malignant disease of the mediastinal lymph nodes and of the forty-seven, eighteen are diagnosed as lymphosarcoma, twenty-nine as Hodgkin's disease. An attempt to collect all the cases from the literature has not been made but it is evident from a general review of the literature that they number in the hundreds.

The origin of the mediastinal lymphosarcomas is not always clear. They may arise either from the mediastinal lymph nodes or the thymus gland. Most commonly they have their origin in the anterior mediastinum and, at first small, they grow rapidly, extending upward to the neck and downward to or over the pericardium to the diaphragm. They extend posteriorly, surrounding the great vessels, trachea and esophagus and may come to fill the space between sternum and spine. Laterally they may extend to and involve the pleura and lung and in the majority of cases do so before death occurs. At autopsy in advanced cases the entire mediastinum may be occupied by a solid tumor mass which involves anterior and posterior mediastinal and bronchial glands and within which may be seen on transverse section the cross section of the great vessels, trachea, bronchi, esophagus and vagus nerves. One is surprised to find that, while these structures are constricted and compressed, their walls are rarely directly infiltrated. The great veins also may escape, but are more likely to be invaded and thrombosed. Extensions of the tumor may present in the neck, in one or both axillae and as retroperitoneal masses below the level of the diaphragm. Metastases may occur to lungs, liver, spleen and other organs.

The tumor mass is as a rule hard and on section presents a white, grayish-white or yellowish-white surface. Necrosis is not the rule, but in large bulky tumors areas of necrosis may be present. On microscopic section there appears "a diffuse growth of lymphoid cells lying in reticular tissue. The structure of the affected nodes or follicles is obliterated. The cells vary in size being small, medium or large. The nuclei are compact or vesicular, always hyperchromatic and nucleoli are not prominent. Large multinuclear cells are occasionally seen." (Ewing.)

The symptomatology of the malignant lymphocytoma which was omitted, is similar to that of the lymphosarcoma, so that the clinical manifestations of the two conditions may be considered together. A

review of the symptoms of mediastinal lymphosarcoma makes it difficult to present a constant clinical picture. The condition is seen most commonly between thirty and fifty years of age and twice as often in males as in females. The chief symptoms are pain, tumor or swelling and signs of mediastinal compression. There is the greatest variation in the time of appearance of these symptoms. In one case pain in the chest or behind the sternum or simulating intercostal neuralgia may be the initial symptom to be followed by the appearance of a swelling in the neck and cough, dyspnea and cyanosis. Again a swelling in the neck at the suprasternal notch may be the first sign to be followed by others. Not infrequently cough with a slight amount of expectoration and dyspnea on exertion are the first evidences of the condition.

As the disease progresses the symptoms become more exaggerated. Pain is dull and aching or sharp and paroxysmal. Tumor is a less constant finding; but visible, palpable tumors may occur in the neck, axilla, over the sternum due to its perforation or to the side of the sternum due to the perforation of rib or intercostal space. Cough and dyspnea increase and are associated with cyanosis; and hoarseness due to pressure on the recurrent laryngeal nerve, dysphagia due to compression of the esophagus, vomiting due to vagal irritation, occasionally hiccough and eye changes due to involvement of the sympathetic nerve, may all supervene. Sudden edema of the face and neck may appear at any time in the course of the disease. Swelling of the abdomen and legs with an accumulation of fluid in the peritoneal cavity usually occur late in the disease. Hemoptysis is commonly present and, although seldom severe, was directly responsible for death in 3 per cent of Rose's cases. Emaciation more often is absent. Fever of a low grade is the rule but we have observed a continuously high fever. A leucocytosis of from 10,000 to 15,000 not uncommonly has been observed.

The physical signs, of course, depend upon the size and location of the lesion. A number of cases are reported in which a small tumor so situated as to compress a bronchus has caused symptoms but has failed to give any physical signs, and the lesion has been found at autopsy. The majority of cases, however, present themselves with definite signs. On inspection the face and neck may be suffused, swollen or cyanotic. A tumor in the neck or over the sternum may be evident. One side of the thorax may bulge or be retracted and show

restriction of respiratory movements. Dilatation of the veins of the neck and upper thorax, Horner's syndrome and hoarseness may be evident. Dyspnea may be the most distressing of all symptoms.

Palpation may establish the presence of a swelling in the neck or axilla. Percussion demonstrates the submanubrial dulness indicative of a growth in the superior mediastinum; auscultation may show harsh respiratory sounds as evidence of bronchial compression, and rales indicative of an associated bronchitis. The x-ray shows a shadow which occupies the mediastinum and which may be sharp and circumscribed or diffuse. Pleural effusion, sometimes hemorrhagic, is a common complication and may be evident on physical or x-ray examination. Tumor cells may be present in it. A chylous effusion due to occlusion of the thoracic duct was noted in one case.

The diagnosis of mediastinal tumor is usually not difficult, but its identification as a lymphosarcoma may remain in doubt. The removal of an enlarged gland wherever accessible will most quickly establish the diagnosis. Should no external gland be available, the careful aspiration of the tumor with a large trocar at a point where it presents beyond the sternum or in the suprasternal notch may yield tissue which will certify the lesion. Should this method also fail we have to fall back on diagnosis by exclusion.

The prognosis is poor. The disease progresses rapidly and is a fatal malady. In Rose's series the average duration of the disease from the first symptom until death was thirty-two weeks. Forty-three patients died of exhaustion, eleven of asphyxia, three of hemorrhage, two of cardiac failure and one of cerebral tumor.

Surgery has thus far achieved little in the treatment of malignant lymphosarcoma and lymphocytoma. A few cases have been subjected to surgery but the attempt at extirpation was abandoned because of the extent of the lesion. At the present time x-ray and radium would appear to be the only means of treating these lesions. It is well known that the tumors arising from lymphoid tissues respond favorably to x-ray and radium therapy and there are many reports in the literature, which our own experience confirms, of the decrease in size or the total disappearance of the mediastinal shadows, with a corresponding improvement in symptoms. The improvement, however, in our experience is temporary and we have not yet observed a cure.

P. I., (80347) N. Y. H. The patient was a 34 year old man who was admitted to the hospital November 5, 1934, with a complaint of substernal



soreness unassociated with activity or respiration of four weeks' duration. Three weeks before admission he became suddenly short of breath and began to notice an aching pain between the shoulder blades while walking up stairs. He had had a dry, non-productive cough during the past four weeks but no fever, night sweats or hemoptysis. His appetite had been poor. On examination he did not appear ill and was suffering from no apparent respiratory distress, but there were the classical signs of effusion in the left pleural cavities.

During his stay in the hospital thoracentesis was performed repeatedly, fluid rapidly accumulating. X-ray therapy was instituted, a total of 3795 R units being administered to the chest over a period of three months. Fluid ceased accumulating in his chest. Biopsy of an axillary lymph node yielded a diagnosis of lymphosarcoma. During his stay he developed left otitis media with facial palsy, Horner's syndrome on the left, thrombophlebitis of the left arm with swelling of the arm and face, ascites, and finally a low-grade fever. Toward the end of his life he was greatly troubled by nausea and vomiting, and although his caloric intake was good, he steadily lost weight. He expired on the one hundred seventy-fifth hospital day.

Anatomical diagnosis at autopsy was lymphosarcoma involving mediastinal, cervical, mesenteric, retroperitoneal and inguinal lymph nodes; lymphosarcomatous infiltration of liver, kidneys, spleen and pancreas; pleural effusion, bilateral; adhesive pleurisy over the entire left lung with lymphosarcomatous infiltration; peripelvic hemorrhages of kidneys; adhesive pericarditis with pericardial ecchymoses; congestion and edema of the left lung, and ascites.

#### HODGKIN'S DISEASE

It is not within the scope of this paper to take up in detail the various manifestations of Hodgkin's granuloma. As is well known, the disease presents a definite histologic picture which is regarded as pathognomonic of the condition. Microscopic sections show diffuse cellular hyperplasia with varying proportions of proliferating endothelial cells, endothelial giant cells, plasma cells and eosinophilic leucocytes. The disease, beginning usually with the enlargement of a chain of lymph nodes, most often in the neck, spreads to the axillary, inguinal, bronchial, mediastinal and retroperitoneal glands. A splenic tumor develops in 60 to 70 per cent of the cases, as does enlargement of the liver. With the generalization of the disease, fever, night sweats, anemia and cachexia appear.

Mediastinal Hodgkin's disease is but one manifestation of this disease. In a few cases the mediastinum appears to be the primary seat of the disease which may progress insidiously until pressure

symptoms call attention to it. Much more frequently the mediastinal glands become involved secondarily to the cervical and axillary glands so that the disease is well established before symptoms referable to the mediastinum become evident. The enlarged glands here as elsewhere may remain discrete and consist of a mass of individual glands loosely held together by connective tissue, or the disease may show invasive qualities and form a large solid mass which surrounds the trachea, bronchi and great vessels. Mediastinal tumors of this sort may form the chief lesion of Hodgkin's disease, filling the mediastinum and compressing its various structures. Extensions to the pleura, lungs, pericardium and heart muscle have been observed.

The symptomatology and physical signs resemble those in lymphosarcoma and reference may be made to our comments under this subject. The x-ray of the chest shows as a rule, a broad sharply defined mediastinal shadow usually quadrilateral in shape and extending from the cardiac shadow upward to the neck. The diagnosis often can be made from the clinical picture alone, but the histologic study of a gland removed for biopsy, remains the most certain means of diagnosis.

X-ray or radium treatment remains at present the best form of therapy. It is gratifying in some cases to observe the rapid reduction in size and even the complete disappearance of large mediastinal masses causing compression symptoms and to witness the cessation of urgent and distressing symptoms. In our experience and, it would appear, in the experience of the majority of observers, x-ray treatment is after all but palliative; for the mediastinal mass, in course of time, reappears and the patient dies of the disease. The duration of life, however, may be prolonged up to five or more years.

N. G., (45318) N. Y. H. The patient was a 15 year old boy who had been treated for diabetes with insulin and diet for two years previous to admission. Two years earlier at about the time of the onset of the diabetes, the patient first noticed a slight pain at the base of the left side of the neck. This pain soon went away and a swelling appeared. Six months later a painless swelling was felt in the left axilla. During the next nine months the patient received eight x-ray treatments for these swellings, during which time they gradually increased in size but had periods of remission. During the eight months following x-ray treatments the patient had severe itching, especially of the thighs, and weakness after moderate exercise. No other symptoms were present.

Physical examination on admission showed an area of dulness in the right chest and the mediastinum enlarged to percussion. X-rays of the chest

showed a very large mediastinal shadow extending outward from the right hilum and to a lesser extent from the left hilum. Biopsy showed a picture typical of Hodgkin's granuloma.

During his hospital course, the blood sugar was controlled with insulin and diet. After the diagnosis of Hodgkin's disease had been established by biopsy, he received a treatment of deep x-ray therapy and was discharged to return for further therapy. Three months after discharge the x-ray showed no appreciable change in the size of the process at the right hilum, although the density appeared slightly increased. (Figs. 28 and 29.)

#### SARCOMAS

The primary sarcomas of the mediastinum, as distinguished from the metastatic sarcomas, form a miscellaneous group of malignant tumors. They may arise from the connective tissue elements of the mediastinal lymph glands, from the thymus, from the connective tissue of the blood vessels and other structures, and from the tendons and periosteum of the sternum, ribs and spine. They may arise also through the malignant degeneration of the benign connective tissue tumors, particularly the fibromas, xanthomas and chondromas, and of the neurogenic tumors such as the neurofibromas and ganglioneuromas. We have already discussed the sarcomas of the thymus and the lymphosarcomas and have called attention to the sarcomatous degeneration of the benign mediastinal tumors. We shall concern ourselves here with other sarcomas which we have observed and collected from the literature.

In our own experience such other sarcomas are rare. In 145 cases of tumor of the mediastinum in our New York Hospital series, but seven are positively diagnosed as sarcoma and of these three are the result of sarcomatous degeneration of previously benign tumors. Of the remaining four sarcomas, two are diagnosed as liposarcoma and one as an apical sarcoma arising presumably from the sheath of the subclavian artery. In the literature from 1926 to the present time we have found reports of thirty-two cases of sarcoma, seventeen of which are designated as "fibrosarcoma" or "fibroblastoma," thirteen as sarcoma and one each as hemangiosarcoma and liporhabdomyosarcoma.

The tumors occur in the apical region and in the anterior and posterior mediastinum. The apical tumors may extend outward and downward encroaching upon the pleural cavity and compressing the apex of the lung, and in certain cases may give rise to symptoms of the superior sulcus tumors. Those arising from the sternum and costochondral region extend posteriorly and encroach upon the

anterior mediastinum; while those arising from the spine, costo-vertebral articulation, etc., grow anteriorly and encroach upon the posterior mediastinum. Some of the posterior tumors arise from sheaths of the spinal nerves and they, together with the tumors arising from the connective tissue of the spine, form hour-glass tumors which are described under a separate heading.

The tumors vary in size from very small to large growths. Not infrequently they are circumscribed tumors which in the x-ray film represent a clearly defined spherical shadow, and the majority of instances observed by us were tumors of that sort. They may, however, in their growth, break through their capsule and surround and involve the mediastinal structures.

Symptoms depend in part upon their size and the rapidity of their growth. They are those of other mediastinal tumors and consist of pain, cough, dyspnea and other symptoms of mediastinal pressure already referred to. As a rule the symptoms come on more slowly and progress less rapidly than those due to the more malignant lymphosarcomas and may not become urgent for a considerable period of time. The physical signs also resemble those of other tumors except when a tumor, arising posteriorly, extends through an intervertebral foramina causing compression symptoms of the cord, or arising in the apical region gives rise to the characteristic symptoms of the superior sulcus tumors. X-rays of the chest in anteroposterior and lateral views may demonstrate the location of the tumor in the anterior or posterior mediastinum and, in some cases, demonstrate its nature.

The diagnosis may be difficult and even impossible. The presence of a tumor, which in all respects including the x-ray shadow, resembles the benign tumors we have discussed, makes the differential diagnosis between benign and malignant tumor difficult. Aspiration biopsy, when the location of the tumor is such as to make the procedure safe, may yield positive information. In the late stages of the condition, when invasive extension to other structures has taken place, the diagnosis of malignant tumor may be evident.

Surgical removal in the early stages of the disease would appear to be the treatment of choice. The possibilities of such treatment, when we consider the results obtained in the treatment of other circumscribed but benign tumors, must be evident. Up to the present time, however, the results of surgical treatment have not been brilliant. Of the four sarcomas in our own experience mentioned

above, all were explored; in two, the tumor was satisfactorily removed; in two it was impossible to remove the tumor and a biopsy was done. Of the two in which the tumor was removed, one had a recurrence of the disease about a year after operation and later died; while one is alive and free from recurrence three years later.

Of the thirty-two cases collected since 1926, 19 patients were subjected to operation. In eighteen the tumor was removed with ten recoveries and eight deaths. The late results in those who recovered are not completely stated. Of the seven patients with fibrosarcomas removed with recovery, three died within six months of operation.

#### SECONDARY OR METASTATIC SARCOMAS

The metastatic sarcomas of the mediastinum are comparatively rare, the lungs being the seat of metastatic nodules so much more frequently. In our own experience there are but few instances in which metastatic nodules have primarily been deposited in the mediastinum, and our survey of the literature would lead us to believe that this generally has been true. We do not think it is necessary to comment upon them.

#### CARCINOMAS

Like the sarcomas, the carcinomas of the mediastinum form a miscellaneous group of lesions. Primarily they arise from the reticulum cells of the thymus gland; secondarily they may arise as extensions from a primary carcinoma of the lung, trachea or bronchus, breast or esophagus, or as a metastatic growth from primary carcinoma elsewhere.

Primary carcinomas are less common than the lymphosarcomas and other sarcomas. Various authors have, from time to time, collected and studied the cases reported in the literature and have found that the true primary carcinoma of the mediastinum is an infrequent tumor. Crosby, in his study of the malignant tumors of the thymus, found that of 166, 122 were sarcomas and forty-four carcinomas. In Ross' carefully studied series of sixty cases of malignant mediastinal tumor, forty-four are sarcomas and ten carcinomas. While the thymus gland appears to be the chief source of primary carcinomas, other carcinomas, the origin of which is not always clear, may involve the mediastinum. In our series are four superior sulcus tumors which are carcinomatous in nature, the origin of three of which is estab-

lished but the origin of the fourth, an epithelial carcinoma, remains unknown. Other similar cases are reported.

The pathology of the primary mediastinal carcinomas need not be detailed. Like the sarcomas, those arising from the thymus gland may reach a considerable size and filling the anterior mediastinum, may subsequently surround the trachea, bronchi, great vessels, nerves and esophagus. They may extend to the pericardium, pleura and lung and metastasize to the pleura, lung, liver, spleen, kidney and other organs. The superior sulcus tumors have been described in another part of the paper.

The symptomatology of the carcinomas arising from the thymus cannot be differentiated from that of the sarcomas arising from the same structure. This has been described under tumors of the thymus and need not here be repeated. The carcinomas occupying the superior sulcus give rise to symptoms and physical signs which are distinctive, and reference may be made to our brief description of the symptomatology of these lesions.

The diagnosis of carcinoma may remain in doubt but it is usually possible to make a diagnosis of malignant disease. In a high percentage of cases the superior sulcus tumors have been carcinomas. The removal of an available gland may establish the correct diagnosis.

The treatment of the carcinomas arising from the thymus gland is unsatisfactory and is pretty well limited to the use of x-ray and radium. Of the five cases of superior sulcus tumor in our series, exploration was carried out in all, but more with the purpose of relieving pain by simultaneous division of the proper sensory nerve roots than with the hope of curing the lesion.

#### SECONDARY MEDIASTINAL CARCINOMAS

In our experience, secondary invasion of the mediastinum has occurred most frequently from primary carcinoma of the bronchus and lung. Carcinoma of the mediastinum also, in our experience, is not infrequent in association with carcinoma of the esophagus. In our explorations for the latter disease, the mediastinal glands frequently have been involved and to such an extent as to make the primary lesion inoperable. We have not, however, in this condition seen the extensive carcinomatous masses described by others, sufficiently large to cause compression symptoms. Primary carcinoma of the breast is another source of mediastinal extensions or metastases which usually occur late in the disease. Metastases from primary

carcinoma in more distant organs may occur, although rarely in the mediastinum.

The metastatic carcinomas require no particular comment. Occasionally the metastatic lesion may give rise to the major symptoms, the primary lesion remaining undiscovered until autopsy reveals it.

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# The American Journal of Surgery

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A PRACTICAL JOURNAL BUILT ON MERIT

## EDITORIAL

### MONOGRAPHS

IN an editorial entitled "Use and Abuse of Advertising Brochures," which appeared in the Journal of the American Medical Association (October 5, 1940), the last paragraph was of special interest to us. In part it read, "The whole field of medical publication is undergoing an obvious transformation. The speed of the times would seem to demand more in the nature of monographic publications dealing with a single subject and less of extensive textbooks which tend to become obsolete, at least in portions of their text, in a short time. Development of this trend for the monograph in the field of unbiased literary production would be useful to the medical profession . . ."

The American Journal of Surgery was a pioneer in presenting to its readers short monographs by outstanding men in their fields of activity. During the past two years we have published the following monographs:

Arthur E. Hertzler—"Technique of Thyroidectomy," November 1938.

Rudolf Keller and Edward Singer—"The Role of the Electrical Potential Cells and Tissue Fluids in Normal and Pathologic Metabolism," January 1939.

William M. Shedden—"Carcinoma of the Rectum and Sigmoid," May 1939.

George T. Pack and Edward M. Livingston—"General Technique of Operations for Gastric Carcinoma," July 1939.

Edward Levy—"Formation of Pelvic Viscera and Their Outlets on the Surface," August 1939.

Elliott C. Cutler and Robert Zollinger—"Surgery of the Gallbladder and Extrahepatic Bile Ducts," January 1940.

Herbert Thoms—"The Estimation of Pelvic Capacity," March 1940.

Julius Jarcho—"Placenta Previa: Roentgen Diagnosis, Treatment and a Technique for Induction of Premature Labor," May 1940.

Arthur Goetsch—"The Diagnosis and Treatment of Hyperthyroidism and Associated Conditions," September 1940.

George J. Heuer and William DeWitt Andrus—"The Surgery of Mediastinal Tumors," October 1940.

Stuart W. Harrington—"Diagnosis and Treatment of Various Types of Diaphragmatic Hernia," which appears in this current issue.

We agree that the monograph is a valuable addition to surgical literature. It contains in a nut shell what a reader is looking for without his being obliged to wade through numerous articles on different phases of a given subject. And we have also noticed that other surgical publications have featured monographs since and long after we started the practice.

Then, too, we are of the opinion that the written-to-order Special Numbers, edited by surgeons of outstanding reputation, are of great value. In cases in which a monograph would not cover the topic adequately, a series of articles by recognized authorities have been written on subjects more or less related. These articles, appearing in one issue, have proved popular and our readers have asked that we continue this practice. During the past two years we have published the following symposia:

"Traumatic and Industrial Surgery," edited by Dr. Allen D. Lazenby, December 1938.

"Reconstructive and Plastic Surgery," edited by Dr. Fred H. Albee, February 1939.

"Surgery of the Extremities," edited by Dr. W. Wayne Babcock, April 1939.

"Large Intestine," edited by Dr. Charles Gordon Heyd, October 1939.

"Emergency Surgery," edited by Dr. Roy D. McClure, December 1939.

"Obstetrics and Gynecology," edited by Dr. Fred L. Adair and Dr. Emil Novak, April 1940.

In our forthcoming issue for December we have a very important and practical Special Number on Office and Minor Surgery arranged and edited by the author.

The practice of publishing monographs and special numbers will be continued by this Journal. We are always searching for topics we hope will prove both instructive and interesting. Therefore, suggestions from our readers are always welcome. Our main ambition is to publish a Journal that will be valuable, readable and to your liking.

T.S.W.



# ORIGINAL ARTICLES

## TRIGEMINAL NEURALGIA WITH DEMONSTRABLE GROSS CAUSATIVE LESIONS\*

### REPORT OF FIVE CASES

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FREQUENTLY pathologic causes of major trigeminal neuralgia are not clearly demonstrable. This statement pertains to the classic type of the disease described by Fothergill (1773),<sup>1</sup> i.e., the disease which is characterized by: (1) severe paroxysmal attacks of darting pain confined to the distribution of one or more branches of the trigeminal nerve; (2) attacks occurring spontaneously or precipitated by stimulation of trigger zones; (3) the absence of neurologic findings.

Many other types of facial neuralgia that do not conform to Fothergill's description have generally been called atypical. Unless the disease is characteristic of the classic type, relief by surgical treatment has usually been reported as unsatisfactory. The so-called atypical syndromes have even been considered by some authors to be contraindications to surgical treatment; while this generalization is justified in some cases, there are notable exceptions.

Any further classification of facial neuralgia, aside from the classic and atypical types, is almost impossible. However, of the atypical cases two general groups can be recognized, viz., those which can be expected to respond to surgical treatment, and those which cannot be expected to respond. In the former group the pain may vary considerably in character, but it follows the anatomic distribution of one or more branches of the trigeminal nerve, and neurologic findings are usually present.

In the atypical cases which probably will not respond to surgery, these conditions are generally not present.

The first authentic case of major trigeminal neuralgia (classic tic douloureux) recognizable as such, was that of Dr. Johannes Laurentius Bausch, reported by Johannes Michael Fehr and Elias Schmidt (1771), five years after the death of the patient.<sup>2</sup> The first accurate account, however, was by Fothergill. According to the record of his cases, objective neurologic findings either were not recorded or were absent.

At Spiller's suggestion, Frazier (1901)<sup>3</sup> established a safe operation for the classic type of the disease, namely, posterior root section; this gave uniform and permanent relief. More recently Sjöqvist (1938)<sup>4</sup> made an extensive fiber analysis of the trigeminal tract and corroborated and added to the earlier findings of Adrian and Zotterman (1926),<sup>5</sup> Gasser and Erlanger (1927),<sup>6</sup> and others, showing that the pain and temperature fibers segregate themselves in the pons and descend downward in the trigeminal tract through the medulla. He further pointed out that section of the trigeminal tract in the medulla at the level of the inferior olive gave uniform relief from major trigeminal neuralgia. Moreover, the procedure allows exploration of the cerebellopontine angle for possible causes and gives anesthesia for only pain and temperature, while touch and pressure are preserved.

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Numerous other reports have appeared in the literature with reference to treatment, e.g., alcohol injection, trichlorethylene, and more recently vitamin therapy. Of these, alcohol injection can reasonably be expected to give temporary relief; other forms of treatment, however, have generally been unsatisfactory. Thus, it becomes apparent that permanent relief in the classic type of case can be expected only by section of the sensory root of the trigeminal nerve, as originally advocated by Spiller and Frazier, or by tractotomy as recommended by Sjögqvist.

A considerable number of contributions regarding etiology have been made, but in comparatively few instances have actual causes been definitely established. Parker (1928)<sup>7</sup> reported four cases of major trigeminal neuralgia which developed during the course of multiple sclerosis; in one, post-mortem examination showed sclerotic plaques on the descending root and nucleus of the trigeminal nerve at the level of the inferior olive; other plaques involved the root of the nerve in the pons.

According to Dandy (1934)<sup>8</sup> vascular anomalies and neighboring neoplasms, such as tortuosity of the basilar artery, venous anomalies of the petrosal sinuses, acoustic neuroma, etc., have caused major trigeminal neuralgia by direct pressure on the root of the trigeminal nerve, relief being obtained by removal of the cause or radicular section. Trauma has been described as an etiologic factor by Alajouanine and Thurel (1937),<sup>9</sup> Colucci (1936),<sup>10</sup> Aubertine (1936),<sup>11</sup> and others. Hoff (1934)<sup>12</sup> reported a case that followed the administration of tuberculin for pulmonary tuberculosis. Harris (1935)<sup>13</sup> described four cases in which neuralgia developed after an attack of acute trigeminal neuritis; in his cases, there was a sudden onset of hemianesthesia of the face, followed by partial recovery of sensation and severe attacks of major trigeminal neuralgia. Hevia (1937)<sup>14</sup> reported tuberculosis as an etiologic factor.

Recently Lewy and Grant (1938)<sup>15</sup> reported focal softening located either in the lateral and medial nuclei of the optic thalamus, or in the thalamocortical tract. Furthermore, they observed that in 25 per cent of their patients the number of touch and pain points was reduced in the distribution of the trigeminal nerve (paresis and analgesia), and that the preserved points showed a greater stimulus threshold than normal. In 32 per cent of the patients showing sensory changes, they reported that the changes extended to the corresponding half of the body, and that forty of the fifty patients studied showed pyramidal or extrapyramidal tract involvement.

Thus, it appears that major trigeminal neuralgia probably has a variety of etiologic factors. The so-called atypical syndromes, with which we are here concerned, differ principally from the classic syndrome in that pathologic causes and objective physical signs of organic disease can both be demonstrated. The discussion of a large group of other facial neuralgias having a nondescript character has been omitted since they require an entirely different management; if treated surgically, such patients are generally not benefited. In the cases here reported the character of the pain was somewhat variable, but its distribution was fairly typical of the classic type of the disorder, i.e., it followed the anatomic distribution of the trigeminal nerve. On the other hand, certain atypical features uniformly presented themselves, viz., etiologic factors were established, and objective neurologic signs of organic disease were present.

#### REPORT OF CASES

*CASE 1. Head injury in a young man followed immediately by continuous left trigeminal pain; later attacks of major trigeminal neuralgia in the second and third divisions of the affected nerve. Objective findings of left primary optic atrophy, left temporal hemianopia with loss of macular vision, and hypesthesia in all three divisions of the affected trigeminal nerve. Fractional section of the posterior root gave relief.*

The patient, a man of 35 years, was admitted to the hospital September 17, 1933, a few hours after he had sustained a head injury. When admitted, he was quite drowsy and very

evidence of fracture. Spinal puncture gave a pressure of 120 mm. of water; no cells were found. The Wassermann reaction of both blood and spinal fluid was negative.

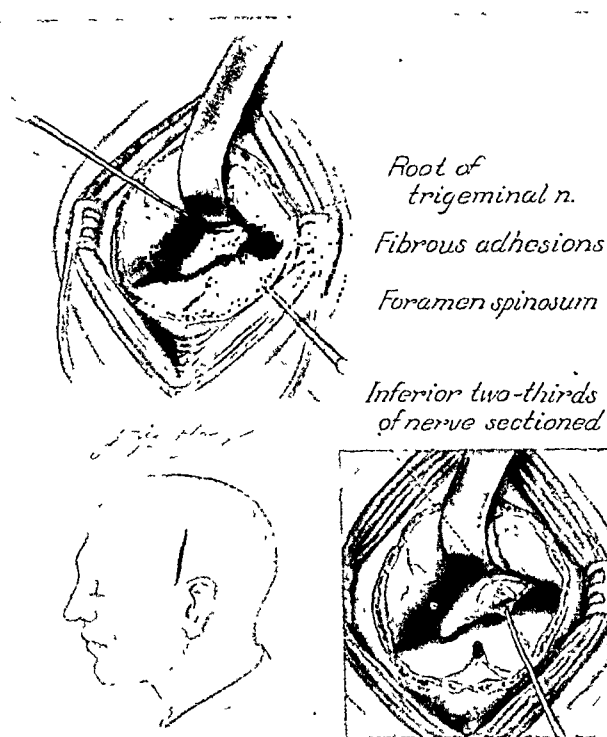


FIG. 1. Artist's conception of adhesions that existed between the dura propria and the posterior root of the trigeminal nerve, supposedly the result of trauma.

little history could be obtained. On the following day he was more alert, but did not know how long he had been unconscious or how he had been injured; other informants told us that he had been struck over the left eye with a shovel, and had been rendered unconscious for less than an hour.

Even on the day of injury while still drowsy he complained of continuous and severe pain in the left side of the face; he also complained of dizziness on change of position. Examination showed: (1) a bruise over the left forehead, (2) semistupor, (3) spontaneous rotary nystagmus, (4) loss of left direct pupillary reaction to light, but normal consensual and convergence reactions: On the following day the patient had regained consciousness, and had the additional complaint of loss of vision in the left eye. Fundus examination revealed nothing abnormal. The visual fields showed complete loss of vision in the left eye except for the inferior nasal quadrant; all macular vision was lost. Roentgenograms of the skull showed no

Ten days later the swelling over the forehead had disappeared; the dizziness had largely subsided, but he still complained bitterly of pain through all three divisions of the trigeminal nerve on the left side. A perimetric field study showed that vision had failed to make any improvement.

Five weeks after the accident the patient was discharged from the hospital, still complaining of pain. The left visual field still showed the same defect; there had been no return of macular vision, and there was beginning primary optic atrophy. After dismissal from the hospital he returned to the outpatient clinic at weekly intervals. The facial pain had not diminished; the visual fields had remained essentially the same, as had the pupillary reflexes.

One year after the accident there had been no improvement in his condition. In addition he was then suffering not only from constant pain but also from paroxysmal attacks of darting pain in the left maxillary and mandibu-



lar regions; there were no trigger zones present. Alcohol injection in the maxillary branch of the nerve was unsatisfactory. Partial relief, for four months, was obtained by injection of the mandibular branch, but then the pain returned with greater severity than ever.

Twenty-one months from the date of the accident (June 12, 1935) the patient was readmitted to the hospital because of severe paroxysmal attacks of darting pain in the second and third divisions of the nerve, as well as constant aching pain through all three divisions. Examination gave essentially the same findings as previously: (1) primary optic atrophy with loss of pupillary reactions to light in the affected eye; (2) hypesthesia in all three branches of the left trigeminal nerve.

Five days later (June 26, 1935) the ganglion and the posterior root of the left trigeminal nerve were explored under local anesthesia. The dura was found to be extremely adherent to the temporal bone, especially in the region of the petrous tip. When the dura propria was opened no spinal fluid escaped. The fibers of the nerve root were adherent to one another and also to the dura propria. The inferior two-thirds of the root were sectioned. (Fig. 1.) During the operation the patient continued to complain of pain, but after the section was performed he felt quite comfortable. A sensory check of the face revealed complete loss of sensation through the mandibular and maxillary branches of the nerve; sensation of cornea, upper eyelid, and forehead showed only the amount of impaired sensation that had been present since the accident. Since there had been no paroxysmal pain in the ophthalmic division of the nerve, the root was not completely sectioned and corneal sensation was preserved.

Twelve days after operation there had been no return of pain. The patient stated that he felt a dull drawing sensation about the forehead and upper eyelid, but that it was not painful. He was then discharged from the hospital with slight drainage from the wound which healed completely by the end of four weeks. He returned at monthly intervals for the following year. When he was last seen (July 6, 1939) four years after operation, there had been no return of pain and he had been working for two and one-half years; other physical findings were essentially the same.

*Comment.* In this patient trauma must have played an important rôle in the production of trigeminal neuralgia. Furthermore, the syndrome was atypical in several respects: (1) no trigger zones were present; (2) there was continuous dull pain between the sharp paroxysmal seizures; (3) objective neurologic findings were present; (4) the affliction came on following craniocerebral trauma; (5) operation disclosed atrophy of the fibers of the posterior root of the nerve, plus adhesions to both the dura propria and the nerve fibers themselves. Fortunately for this patient, posterior root section afforded complete relief; this had not been possible by alcohol injection.

*CASE II. Atypical major trigeminal neuralgia in a middle-aged woman for seven years. Impaired sensation of the face, tinnitus, and loss of hearing on the affected side. Exploration revealed pressure grooving of the affected nerves from anomalous veins; electrocoagulation and resection of the veins gave complete relief.*

A 57 year old woman was admitted to the hospital (June 3, 1938) because of severe pain on the left side of her face. Seven years previously she had suffered the first attack of pain, located in the lower left side of the face and base of the tongue. Since that time she had had more or less continuous dull aching pain which had radiated through the area innervated by the left maxillary and mandibular divisions of the trigeminal nerve. Tingling had occurred in the upper lip on several occasions and had continued for two or three weeks at a time. During the attacks there were, in addition to continuous pain, frequent paroxysms of severe electric shock-like pain which occurred spontaneously or from stimulation of trigger zones on the lips. These paroxysms had recurred many times daily for periods of weeks or months. At the onset of facial pain, the patient was also aware of buzzing and deafness in the left ear; the deafness had steadily increased.

The woman had suffered from hyperthyroidism fifteen years before (1923) and had been relieved by thyroidectomy. Four years before (1934) she had begun to suffer from attacks of biliary colic; cholecystectomy the same year relieved this condition. She had also

suffered for twenty years from extensive varicose veins of the lower extremities.

Her state of nutrition was good; she was

erated from view by a large varix of the petrosal sinus. After these veins had been electrocoagulated they were resected; then both

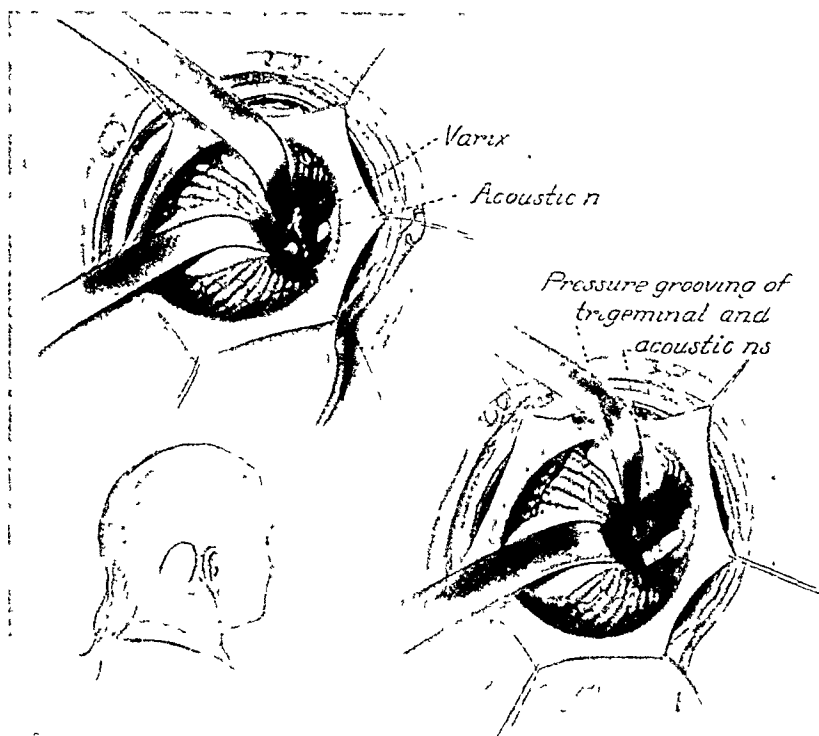


FIG. 2. Venous anomaly involving the trigeminal and acoustic nerves, and pressure grooving of the nerves observed after removal of the varix.

slightly obese. The blood pressure was 134 systolic and 88 diastolic; the pulse averaged 76 beats per minute; the temperature was 98° F. Extensive varicose veins in both lower extremities extended to the hips. The neurologic examination revealed a moderate hemihypesthesia of the face corresponding to the distribution of the maxillary and mandibular branches of the left trigeminal nerve, and a marked impairment of hearing on the left side. Barany's test on the left side gave a sluggish response from both the horizontal and vertical canals, and there was no constitutional reaction or past pointing. On the right side the findings were normal. The neurologic examination was otherwise negative. Roentgenograms of the skull disclosed no abnormality. The Wassermann reaction of both blood and spinal fluid was negative. Analysis of blood and urine revealed nothing abnormal.

On June 8, 1938, the left cerebellopontine angle was explored through a unilateral suboccipital approach. Both the trigeminal and acoustic nerves were almost completely oblit-

ated. The acoustic and trigeminal nerves could be seen and showed definite pressure grooving. (Fig. 2.) Since an adequate cause for the symptoms was found and removed, the root of the trigeminal nerve was not sectioned.

The day after operation, stroking of the face where trigger zones had previously existed failed to bring on an attack of pain, and the continuous pain had also disappeared. Buzzing in the ear had subsided, but impaired sensation of the face and loss of hearing were about the same as preoperatively. The patient was discharged from the hospital on the fourteenth postoperative day, completely free from pain. When last seen (December 9, 1938) six months after operation, there had been no return of symptoms. The impairment of sensation in the face had largely disappeared and hearing had markedly improved.

*Comment.* The illness of this patient whose illness was in some respects fairly typical of the classic type of major tri-

geminal neuralgia. The symptoms differed, however, in that dull aching facial pain was constantly present between the parox-



FIG. 3. Note particularly the abnormally increased width of the right internal acoustic meatus and the adjacent area of calcification.

ysmal attacks, and objective neurologic findings were present. Because the physical findings led to a diagnosis of an organic lesion involving both the acoustic and trigeminal nerves (thought probably to be neoplastic) the suboccipital approach to the cerebellopontine angle was chosen, and this disclosed the unusual varix.

The writer does not wish to postulate an increased tendency of varices to develop within the cranial cavity because of their presence to an extensive degree in the lower extremities. However, when an intracranial condition does develop, as in the case of this patient, extensive varicosities elsewhere in the body may possibly serve to indicate the nature of the lesion. Lastly, it was gratifying that both auditory and trigeminal nerve symptoms disappeared following destruction of the varix; thus, the necessity of a subsequent operation with consequent sacrifice of cranial nerve function was obviated.

**CASE III.** *Attacks of major trigeminal neuralgia and constant right facial pain for seven years in an elderly woman. Deafness in the right ear for nineteen years. Hypesthesia of the right side of face. Roentgenographic evidence of localized calcification at the right internal acoustic meatus.*

*Fractional section of the posterior root of the right trigeminal nerve gave complete relief from symptoms.*

A 67 year old woman was admitted to the hospital August 8, 1934 because of attacks of severe pain in the right side of the face. She stated that the first attack had occurred seven years previously early one morning while she was brushing her teeth, and that for several weeks thereafter she had suffered from paroxysmal attacks of pain which radiated to the right side of the nose, teeth, and tongue. Since that time she had suffered from constant dull aching pain in the right side of the face, with exacerbations and remissions of the paroxysmal pain lasting several weeks at a time.

Further interrogation revealed that nineteen years previously (1919) she had suffered from continuous ringing in the right ear which had subsided after six months; then deafness was first noticed. By the end of three or four years she had become totally deaf in the right ear.

The patient was well nourished, with a blood pressure of 150/86, pulse of 70, and temperature of 98.4°F. The neurologic examination gave the following findings: (1) moderate hypesthesia through the distribution of all the branches of the right trigeminal nerve; (2) absence of the right corneal reflex; (3) trigger zones at the right nasolabial fold which when stimulated precipitated seizures typical of major trigeminal neuralgia, (4) total loss of hearing in the right ear. Barany's test on the right side produced no nystagmus from stimulation of either the vertical or horizontal canals, and there was no constitutional reaction or past pointing. On the left side there was no response from the vertical canals and only a slight nystagmus from the horizontal canal; there was no constitutional reaction and only slight past pointing.

Roentgenograms of the skull disclosed a circumscribed area of increased density approximately 2 cm. in diameter at the right internal acoustic meatus. (Fig. 3.) Spinal puncture gave a pressure of 70 mm. of water; the fluid was clear; there was one cell, and no increase in total protein. The Wassermann reaction of both blood and spinal fluid was negative. The blood count was within normal limits, and urinalysis gave normal findings. A calcified acoustic neuroma was presumably present, but had apparently been quiescent for a number of years. Several previous alcohol injections had been unsatisfactory. Permission for posterior root

section of the trigeminal nerve was refused though the patient begged for relief from pain.

Two years later (February 20, 1936) she was

nerve. (Fig. 4.) Later microscopic study of a biopsy revealed the characteristics of a perineural fibroblastoma.

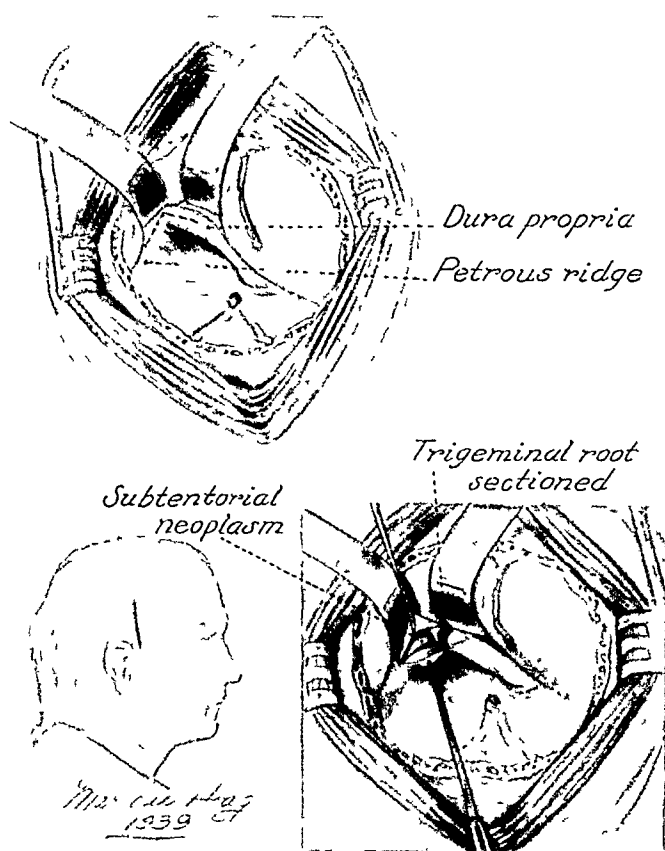


FIG. 4. Neoplasm of the posterior fossa (probably an acoustic neuroma) pressing on the posterior root of the trigeminal nerve.

readmitted to the hospital for further observation and treatment. Examination at that time gave essentially the same findings as previously, with the exception that there was almost complete anesthesia in the area of distribution of the third division of the right trigeminal nerve (probably the result of alcohol injection). Barany's test was repeated and gave the same results as before. Roentgenograms showed the area of increased density (calcification) at the right internal acoustic meatus unchanged. Routine findings otherwise were essentially normal.

Six days later (February 26, 1936) consent for operation was obtained and the posterior root of the right trigeminal nerve was sectioned by way of the temporal approach. The dural incision also was extended farther posteriorly through the tentorium and the upper border of an encapsulated tumor (presumably of the acoustic nerve) came into view; it apparently was pressing on the root of the trigeminal

nerve. Convalescence was uneventful and the patient was discharged from the hospital on the sixteenth postoperative day free from pain. When last seen two years after operation (October 9, 1938) there had been no return of pain; roentgenograms showed no increase in the area of density (calcification) near the right internal acoustic meatus, and there were no clinical signs of increasing intracranial pressure.

*Comment.* This patient's complaint on admission was primarily that of a typical case of major trigeminal neuralgia. However, continuous burning pain between the severe paroxysmal attacks and objective neurologic findings placed it in the atypical group. At operation a gross pathologic cause for the disturbance was found. The earlier symptoms of involvement of the acoustic nerve had never been a source

of complaint. In the initial history she actually denied tinnitus and deafness, but after the examination showed involvement of the trigeminal and acoustic nerves on the right side and also positive roentgenographic evidence of a lesion in the right cerebellopontine angle, she finally admitted having suffered from tinnitus and deafness twenty years before. In this atypical case it will again be noted that the pain was confined to the anatomic distribution of the trigeminal nerve.

Now the question might arise as to why an attack was not made upon the tumor rather than selecting the temporal approach for section of the root of the trigeminal nerve. Several factors determined the selectivity of the treatment employed: (1) the advanced age of the patient; (2) the absence of signs indicative of any increase in size of the tumor for several years; (3) the increased danger involved from complete removal of the tumor; (4) the complete facial paralysis that would have resulted from such a procedure; (5) the presence of pain was the patient's only reason for presenting herself for treatment.

*CASE IV. A young woman who had suffered continuous pain and progressive loss of sensation in the distribution of the right trigeminal nerve for one year. Arrested pulmonary tuberculosis. Operation disclosed a chronic inflammatory process involving the dura propria, ganglion, and posterior root of the trigeminal nerve; section of the root gave relief from pain.*

The patient, a woman of 29 years, was first admitted to the hospital April 12, 1928 because of abdominal pain. A diagnosis of acute appendicitis was made, and the appendix was promptly removed. The pathologic examination, however, failed to show any inflammatory changes. The postoperative convalescence was uneventful.

The patient was again admitted to the hospital six years later (May 20, 1934), this time because of pain in the left shoulder. Examination revealed a moderately advanced pulmonary tuberculosis in the upper lobe of the left lung. She was then sent to Olive View Sani-

tarium where she was treated, and discharged six months later as an arrested case.

She was not heard from again until three more years had elapsed, at which time she was complaining of left facial pain. At the onset one year previously the pain had been confined to the left eye, but on readmission to the hospital (July 2, 1937) it had involved both the first and second divisions of the nerve; the pain also had increased in severity. There was no history indicating that trigger zones had been present, and there had been no paroxysmal attacks of pain, but there was increasing numbness of the face. The patient had lost considerable weight.

Impaired sensation in the first and second divisions of the left trigeminal nerve was noted. Roentgenograms of the skull showed no abnormality. The spinal fluid examination was not remarkable.

Four months later, October 8, 1937, the pain had become more severe and had involved all three divisions of the left trigeminal nerve. Because of severe pain on eating, an adequate diet could not be maintained. This resulted in a loss of 15 additional pounds. The area of impaired sensation had spread to all three divisions of the nerve. Spinal fluid examination again gave normal findings. Because of the progressive nature of the disease a diagnosis was made of an organic lesion (presumably neoplastic) involving the left trigeminal nerve.

Four days later the right Gasserian ganglion was explored. The dura in the region of the ganglion and posterior root was densely adherent to the base of the skull, and actually appeared to be covered with granulation tissue. Careful inspection failed to disclose a tumor. The dura propria was then opened, but no cerebrospinal fluid escaped. The root of the trigeminal nerve was yellowish in appearance, and approximately one-third the normal size; it was adherent to the dura, and the fibers themselves were adherent to one another. The appearance was that of a single cord. Exploration farther posteriorly was not done for fear of opening into the subarachnoid space, which was apparently walled off by adhesions. The entire posterior root of the nerve was sectioned. (Fig. 5.)

The postoperative convalescence was uneventful and complete relief from pain was obtained. Fourteen days after operation the patient was discharged from the hospital and had begun to gain weight. When last seen

seven months after operation, she had regained her lost weight; anesthesia on the right side of the face was complete, and there had been no return of pain.

CASE V. Attacks, in a middle-aged woman, of major trigeminal neuralgia and tinnitus on the left side for twenty years. Barany's test gave findings suggestive of an organic lesion involving

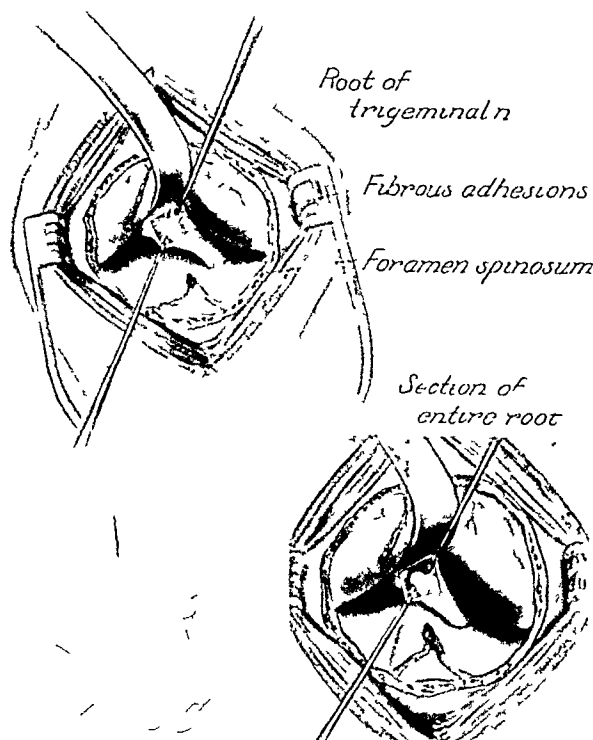


FIG. 5. Note the diminished size of the posterior root of the trigeminal nerve and adhesions to the dura propria. Also the confluence of the nerve fibers forming what appears to be a single cord

*Comment.* Unfortunately in this patient the true nature of the inflammatory process involving the dura propria, Gasserian ganglion, and posterior root, was not disclosed; cultures and smears failed to reveal organisms. Of clinical interest, however, was the resemblance of the symptoms to those of a Gasserian ganglion tumor. At no time during the period of observations was there any indication that a low grade infection existed. On the other hand, there was nothing regarding this patient's illness that suggested major trigeminal neuralgia of the classic type, i.e., the pain was continuous and not paroxysmal, there were no trigger zones, and objective findings were present. Lastly, section of the posterior root gave relief.

the left acoustic nerve. Operation revealed an acoustic neuroma exerting pressure on the root of the left trigeminal nerve. Death occurred the day after operation from coronary thrombosis.

A 54 year old woman was admitted to the hospital September 1, 1937 because of recurring attacks of pain in the left side of the face. She had been suffering from pain in the left side of the face for the previous twenty years. The onset of the first attack, like all the subsequent attacks, was sudden; it came on while she was drinking a glass of cold water, and passed away as quickly as it had appeared; it radiated to the angle of the jaw and the lower teeth. For several months thereafter drinking cold water or partaking of cold food precipitated attacks. The following two or three years she was free from pain, and then the attacks again recurred, this time for a longer period.

When admitted to the hospital, she had been suffering almost continuously for three years; furthermore, the pain had spread to the maxil-

lary branch of the nerve (probably due to previous alcohol injections). Hearing tests for the ordinary range of sounds were normal. Barany's test

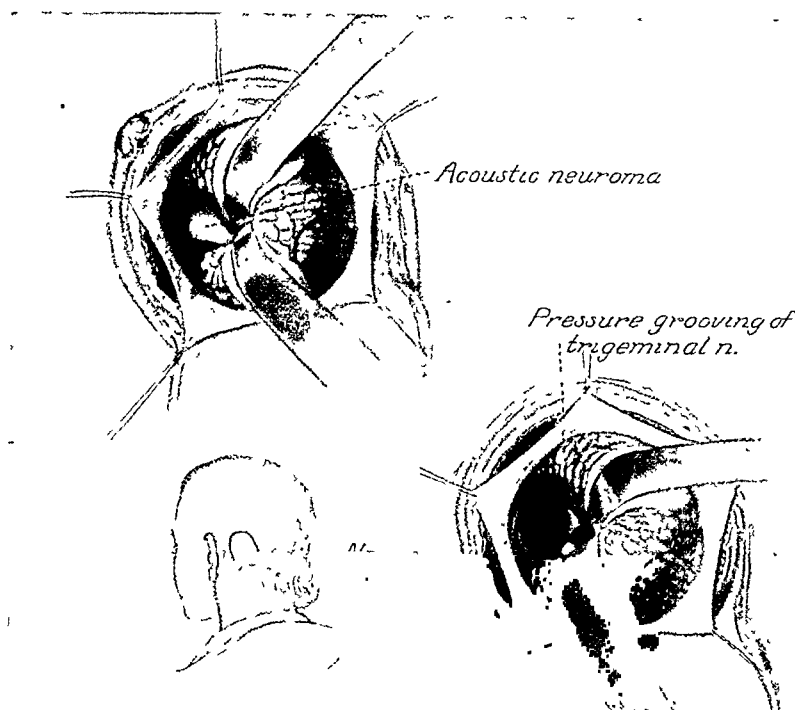


FIG. 6. Small neoplasm of the acoustic nerve and pressure grooving of the trigeminal nerve that could be seen after removal of the tumor.

lary branch of the nerve. No trigger zones had been present.

The patient had suffered the usual childhood diseases, and had gone through three normal pregnancies. The children were all living and well. A hysterectomy was done in 1929 for uterine fibroids.

Further interrogation revealed occasional attacks of ringing in the left ear, which had lasted two or three weeks at a time. She further stated that ringing in the ear had begun prior to the onset of facial pain, but that it had never been a source of discomfort. Alcohol injection of the maxillary and mandibular branches of the affected nerve had given relief for short periods of time, but the last two injections had been unsuccessful.

Examination showed the patient to be well developed, and in a good state of nutrition. The blood pressure was 134/78, the pulse 70, the temperature 98.2°F. Neurologic examination was negative except for the trigeminal and acoustic nerves on the left side.

There were patchy areas of hypesthesia in the maxillary and mandibular branches of the

on the left side gave no constitutional response or past pointing; only a few coarse, perverted, nystagmoid movements appeared after stimulation for four minutes of both vertical and horizontal canals; on the right side the findings were normal. The Wassermann reaction of both blood and spinal fluid was negative. The spinal fluid pressure was 120 mm. of water; there was one cell per c. mm. and no increase in globulin. Urine and blood examinations were not remarkable. Examination otherwise gave normal findings. Because of the history of tinnitus and the findings obtained from Barany's test, a probable diagnosis of acoustic neuroma was made.

The left cerebellopontine angle was explored September 3, 1937 by way of the suboccipital route. A small encapsulated tumor of the acoustic nerve was found, and removed without technical difficulty. After removal of the tumor the root of the trigeminal nerve was observed to have been flattened by the tumor on its inferior and lateral surfaces. (Fig. 6.) Since a reasonable cause for the neuralgia was found and removed, the root of the trigeminal nerve was not sectioned.

The day after operation the patient had recovered from the effects of anesthesia and was in good condition. The blood pressure was 110 systolic and 82 diastolic; the pulse averaged 100 beats per minute; the temperature was 99.8°F. In the evening she partook of a light supper and felt reasonably well; there were no attacks of neuralgia. Two hours later the nurse discovered the patient was dead.

Post-mortem examination revealed moderate general arteriosclerosis; the coronary arteries showed atheromatous changes and recent extensive thrombosis. Examination of the brain except for the ordinary amount of operative trauma was not remarkable.

*Comment.* This patient, like the others, complained chiefly of pain referable to the anatomic distribution of the affected trigeminal nerve; the nature of the pain, however, differed from the others in that it resembled the pain of classic trigeminal neuralgia. The associated atypical features of tinnitus and Barany test findings already described need no further elucidation.

While the pain varied with each case reported and was quite different in some from the pain in the classic type of Fothergill's disease, it will be noted that in all cases it was confined to the anatomic distribution of the affected trigeminal nerve. Furthermore, there were physical signs of organic disease of the trigeminal nerve itself or other regional cranial nerves. If these points are kept in mind the proper selection of cases for surgical treatment should be materially facilitated. Lastly, surgery gave uniform relief and the findings at operation were consistent with the subjective complaints and the objective neurologic signs.

#### SUMMARY

1. Pathologic causes of major trigeminal neuralgia frequently cannot be demonstrated in both the typical and the less clearly defined (atypical) cases.

2. In the classic type of the disorder (Fothergill's disease), relief is most satisfactorily obtained by surgery. In the atypical syndromes surgery has generally

been considered to be contraindicated; however, there are notable exceptions.

3. From the literature it appears that trigeminal neuralgia may have a variety of causes: (1) infections, (2) ill-defined sclerotic changes, (3) neoplasms, (4) vascular anomalies, etc.

4. Any attempt to classify the disease, aside from the classic and atypical forms, is almost impossible. However, two general groups can be recognized: (1) those which can be expected to respond to surgery; (2) those which cannot be expected to respond.

5. In those atypical cases in which relief by surgery may be anticipated, the pain generally follows the distribution of one or more branches of the trigeminal nerve, and neurologic findings may or may not be present.

6. In the cases reported a gross cause for the neuralgia was found which was consistent with the subjective complaints and the objective neurologic findings; relief was obtained by surgery, i.e., either by section of the posterior root of the trigeminal nerve or by removal of the cause.

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THERE can be no dogmatic advice with regard to patients suffering from trigeminal neuralgia as to which form of treatment is the best; every patient must be considered independently.

# EPIPHYSEAL CHANGES RESULTING FROM ACUTE INFECTIONS OF BONE

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THIS study of epiphyseal changes associated with acute hematogenous osteomyelitis was initiated partly because of the large number of records accessible at The Mayo Clinic concerning patients with chronic and acute osteomyelitis. It was felt that the series was large enough to permit the drawing of some conclusions and that the group would represent a cross section of patients who had received various types of treatment from surgeons over a large geographical area. It was hoped to ascertain the frequency of deformities and their variety.

Another reason for the present study was the too frequent use of the word "epiphysitis." In reality, few lesions ever can be demonstrated in the epiphysis and, over a period of years, one epiphysis does not demonstrably differ from its fellow. Experienced surgeons are alert to discount a report that epiphysitis, with subsequent disturbance of growth, resulted from the common osteomyelitis. The young surgeon, however, who has not had long experience in treating this condition and observing the results, may be misled by the general impression that epiphysitis is common.

A report of the survey of literature which preceded the study on which this paper is based was included in an unpublished thesis.<sup>1</sup> For consideration of space it is omitted here.

## MATERIAL

To secure material for study, I reviewed the records of 2,064 patients with acute and chronic osteomyelitis encountered at The Mayo Clinic from 1930 to 1937 inclusive. In any case in which the history or

the report of examination suggested the presence of epiphyseal changes, the record was checked against the roentgenograms. Further study was given only to those cases in which there was definite roentgenologic evidence of epiphyseal change. Cases in which there were changes in joints and closure of the epiphyseal line as a result of infections of low grade, without the usual acute symptoms of hematogenous osteomyelitis and cases of acute traumatic osteomyelitis, with associated epiphyseal changes, were excluded. Cases in which there was lengthening of extremities, without evidence of demonstrable changes in the epiphysis or epiphyseal line, were not included. In many cases in which lengthening of an extremity takes place, the pathologic lesions are too far distant from the epiphyseal line to be considered results of epiphyseal stimulation or irritation; the lengthening possibly results from increased circulation in the diaphysis adjacent to the epiphyseal line.

Of this group of 2,064 cases, sixty-six showed both clinical and roentgenographic evidences of epiphyseal changes following an osteomyelitic condition.

## RESULTS

*Upper Femoral Epiphysis.* In twenty-seven cases a hip joint was involved. In this, the largest group, results were consistently poor. There was no instance in which the epiphyseal line had been spared. In one case, however, there was evidence of a remaining epiphyseal line but it was narrow and abnormally developed in comparison with that of the opposite hip; the epiphysis was flattened and thinner

than normal and there was some irregularity of contour, particularly on the weight-bearing aspect.



FIG. 1. Characteristic changes in hips after early incision and drainage. Absorption of the epiphysis and a portion of the neck of the femur.

In one case, in which treatment had been conservative and roentgenologic examination was made frequently, there was gradual absorption of the juxta-epiphyseal tissue. This was followed by absorption of the epiphyseal cartilage and, at the end of the third month, the epiphysis displayed the characteristics of a sequestrum. Later a sequestrum was removed.

In two cases in which treatment had been conservative pathologic dislocations were present and the epiphyseal lines were closed. The epiphysis or femoral head in one case was intact, although it was smaller than the femoral head on the other side; in the second case the portion of the head adjacent to the ilium had undergone absorptive changes and irregularity of the epiphysis resulted.

In one case, that of an infant nine months of age, there was evidence of complete absorption of the neck of the femur but the epiphysis appeared normal on roentgenologic examination.

Absorption of the epiphysis and a varying degree of absorption of the neck of the femur were evident in four cases. Treatment in all four was by early incision and drainage; there was no evidence of ankylosis. (Fig. 1.)

In two cases, the epiphysis was absorbed without evidence of change in the juxta-

epiphyseal region. In neither case was there ankylosis. Treatment had consisted of early incision and drainage.



FIG. 2. Preservation of the epiphysis and bony ankylosis.

In one case, the epiphysis and the juxta-epiphyseal region were preserved without ankylosis, but destructive and hypertrophic changes had taken place in the head. There was associated change in the acetabulum. Treatment had consisted of early incision and drainage.

In twelve cases, ankylosis was present but part or all of the epiphysis and juxta-epiphyseal region were preserved. In ten cases treatment had been conservative and in two, early incision and drainage had been carried out. (Fig. 2.)

In two cases in which the epiphysis was preserved, ankylosis followed incision and drainage for acute osteomyelitis of the greater trochanter and ilium, respectively.

Another case presented the characteristics of acute inflammation of the upper femoral epiphysis, resulting from osteomyelitis of the neck of the femur; drainage had been instituted late in the course of the disease. There was marked destruction of the epiphysis and the juxta-epiphyseal region without ankylosis.

In this group of twenty-seven cases, the age of onset ranged from 7 to 19 years with the exception of the case of the infant of nine months. Six patients were aged 9 years, twelve were aged 8 years and four, 14 years. The remaining cases were distributed over the other years as single cases or in groups of two.

*Lower Femoral Epiphysis.* This group, composed of fifteen cases, constituted the next to the largest in the series.

the metaphysis, with absorption of the medial epiphyseal line; the absorption extended into the epiphysis. Eight months



FIG. 3. A, involvement of the lower femoral epiphysis; eighteen days following incision and drainage; spotted absorption of the medial epiphyseal line; B, four months following onset; beginning recalcification of the affected portion, with a large region of absorption in medial portion of the epiphysis; C, ten months following onset; closure of the medial femoral epiphyseal line, especially along the periphery; early genu valgum.

In two of the cases the condition was of recent origin and the patients were seen at the clinic early in the course of the disease. In one of these cases, which was of five weeks' duration, there was evidence of absorption in the cartilaginous plate of a medial femoral epiphysis; the absorptive changes had followed acute arthritis of the knee. Drainage had not been instituted. There was no record of late follow-up examination. In the second case, that of a child of 8 years, the history was that the condition had begun acutely, with swelling in a knee, in October 1935. Seven days following this, aspiration of the knee was performed and the periosteum was incised on the medial aspect of the lower part of the femur. On the eleventh day following onset roentgenologic changes were noted. Twenty-nine days following onset and eighteen days following incision and drainage, roentgenologic examination gave evidence of spotted absorption, involving the medial epiphyseal line, and absorption of the cartilaginous disc. Four months from the time of onset, examination revealed recalcification of the affected portion of

following onset, more evidence of calcification was observed; there was a residual lesion resembling a cavity in the metaphysis and extending into the epiphysis. Also there was beginning shortening of the medial aspect of the femur. On clinical examination, ten months after onset, definite shortening and outward bowing were perceptible. Two years following onset, the bone appeared to have healed with complete closure of the medial aspect of the epiphyseal line. (Fig. 3.)

The remaining thirteen patients of this group were seen late in the course of the disease. In three cases there was primary septic arthritis of a knee; in two of these early incision and drainage had been carried out. In one case of the three a genu valgum deformity resulted; in the second case there was ankylosis, with incomplete fusion of the epiphyseal line anteriorly, and consequent overgrowth of the anterior portion of the epiphysis. In the third case, actual shortening of 3 inches (7.5 cm.) resulted from closure of the femoral epiphyseal line. The onset had been at the age of 11 years and the condition had

existed for fourteen years. There was no deformity from deviation and the functional result was fair.



FIG. 4 Anteroposterior view showing a defect in the lateral femoral epiphysis with an associated genu valgum deformity.

In nine of the remaining ten cases the primary focus of infection was felt to be metaphysitis. The epiphyseal changes in the tenth case may have resulted directly from metaphysitis or from septic arthritis of a knee joint, since the knee was secondarily infected following incision and drainage for metaphysitis. The deformity was of genu valgum type and probably resulted from injury to the epiphysis at the time of the original surgical intervention. (Fig. 4.)

Of the nine cases, three presented genu valgum deformity from acute metaphysitis, with associated change in a medial femoral epiphysis. In two of this group of nine cases, early incision and drainage had been done for acute metaphysitis with subsequent epiphyseal changes; varus deformity resulted. Four of the nine cases presented shortening as a result of femoral epiphyseal changes, without deformity from deviation. In two of these four cases drainage was not instituted and shortening was of 1 inch (2.5 cm.) and of  $\frac{1}{2}$  inch (1.25 cm.), respectively. The onset in the first of these two

cases had been at the age of 14 years and the condition had endured twenty-one years; in the other of the two cases, onset was at the age of 12 years and duration of the condition had been four and one-half months. In the two remaining cases of the four, incision and drainage had been effected early; in one, shortening was  $3\frac{1}{2}$  inches (9 cm.) and in the other, 10 inches (25 cm.). In the first of the two cases just mentioned, onset had occurred at the age of 17 years and in the second at the age of 5 years; in both cases the duration of the condition had been fifteen years.

*Distal Tibial Epiphysis.* Involvement of the distal tibial epiphysis comprised the third group in point of numbers of cases; there were eight. In two cases onset was in infancy, in two, before the fifth year, and in the remaining four, at ages 9, 12, 13 and 14 years, respectively. In this group there were several interesting epiphyseal changes.

Two of the patients presented ankylosis of the ankle. In one of these two cases there was lengthening of a tibia; probably the ankle joint was infected secondary to surgical drainage of the focus. In the other case in which ankylosis occurred, there was closure of the epiphyseal line and  $\frac{3}{8}$  inch (1 cm.) of shortening. Drainage had been instituted early and, at the time of examination, the disease had existed for three years.

In two cases varus deformity was present. In one, duration of the disease had been fifteen years from onset at the age of 4 years. In this case drainage had been effected and the bone had been scraped early in the course of the disease; shortening of the tibia by  $1\frac{1}{4}$  inches (3 cm.) resulted. (Fig. 5.) In the second case in which varus deformity was present, the condition had existed for one year after its onset at the age of 14 years; absorption of the cartilage of the epiphyseal line and a residual, thin, smooth line remained. Incision and drainage had been effected early.

Two patients presented a calcaneal deformity; one, seen at the age of 13 years, after the condition had existed thirteen

and roentgenologic examination disclosed two lines in the lower part of the tibia, each with the characteristics of an epi-



FIG. 5. Lateral and anteroposterior views showing shortening of the tibia with varus deformity as a result of epiphyseal involvement early in childhood.

years, had undergone early incision and drainage and presented an unusual deformity. There was a defect in the epiphysis and epiphyseal line of the tibia and the head and neck of the corresponding talus were separated from its body and were occupying the defective space in the epiphysis and epiphyseal line. There was  $\frac{5}{8}$  inch (1.5 cm.) shortening of the extremity with lateral deviation. The second patient who presented calcaneal deformity was seen at the age of 9 years, after the condition had existed for six years. Drainage had been instituted at five and fifteen days, respectively, following the onset of acute symptoms. Examination disclosed that destruction of the medial epiphyseal line had taken place and that the distal end of the fibula was at the lower level of the tarsal bones. There was  $1\frac{3}{4}$  inches (4.5 cm.) of shortening of the extremity, without lateral deviation.

The two remaining patients presented unusual conditions. The disease of both had begun in infancy. One, aged 7 years, had undergone early incision and drainage

epiphyseal line. There was a lesion in the posterior aspect of the tibia which extended through what appeared to be the proximal epiphyseal line and to the normally placed epiphyseal line; the lesion involved the adjacent portion of the epiphysis. The proximal one of the lines, which had the characteristics of an epiphyseal line, represented a growth line, described some time ago, and again more recently by Siegling. He presented roentgenograms of infants after they had ingested phosphorized cod liver oil; growth lines were clearly demonstrated. The remaining of the two patients whose condition had begun in infancy was seen at the age of 5 years. At that time there was extensive osteomyelitic involvement of the shaft of the tibia, absorption of the lower tibial epiphyseal line and the epiphysis presented the roentgenologic characteristics of a sequestrum.

*The Proximal Tibial Epiphysis.* Involvement of a proximal tibial epiphysis was noted in six cases.

Three of this group of patients presented a genu valgum deformity; two of

the three had been subjected to early incision and drainage and the third to the making of multiple drill holes for drainage.



FIG. 6. Anteroposterior view showing sclerotic change in epiphyseal line.

One of the three patients, seen at the age of 10 years, after the condition had existed for two years, presented, on roentgenologic examination, a defect of the epiphysis which was suggestive of a surgical defect. There were absorptive and destructive changes in the anterior epiphyseal line and sclerosing changes in the posterior aspect of the epiphyseal line. The second of these three patients, seen at the age of sixty-four years, gave an indefinite history of an acute infection of bone at an early age. This was drained early and a genu valgum deformity resulted. The third patient of the three, treated by early drilling, was seen at the age of 5 years, after the condition had endured for two years. In this case perimetric hypertrophy of the tibia was present; the epiphyseal line remained open but there were some sclerotic changes. There was actual lengthening of 1 inch (2.5 cm.).

In two cases there was no deviation deformity. One of these two patients, seen at the age of 10 years, after the condition

had existed for three years, presented involvement of the metaphyseal plate and the corresponding portion of the epiphysis



FIG. 7. A, early change in diaphyseal side of lower fibular epiphysis; five weeks after drainage of soft tissue abscess; absorptive changes in fibular epiphysis; a region of the tibial epiphysis is suggestive of absorption. B, fourteen months after onset; fibular and tibial epiphyseal lines of same development; residual scarring epiphyseal line of tibia; fibular epiphysis regenerated, save distal tip.

was growing into the defect. Surgical operation had not been performed. The second of the two patients was aged 13 years and the condition had existed for one year. There was lengthening of  $\frac{1}{2}$  inch (1.25 cm.) and sclerosing changes involved the entire epiphyseal line (Fig. 6).

In the final case, that of a patient aged 22 years, whose condition had existed for five years, drilling for drainage had been done early after onset. Ankylosis of the knee, a genu valgum deformity and 6 cm. of shortening were present.

*Proximal Humeral Epiphysis.* This group consisted of four cases, one of which is described in the section on multiple epiphyseal involvement. The second case, that of a child of 11 years, whose condition had existed for six months, had undergone early drainage; absorption of the upper humeral epiphysis had taken place and destructive changes of the epiphysis were present. In the third case, that of a patient 18 years of age, whose disease had been present for seven years, closure

of the proximal humeral epiphysis and upward growth of the greater tuberosity were evident. Loss of the angle of the surgical neck of the humerus had resulted. The fourth case, that of a patient of 9 years, whose disease was of one year's duration, had been subjected to early drainage; there were involvement of the epiphyseal line and destructive changes in the epiphysis.

*Multiple Epiphyseal Lesions.* Two patients presented multiple epiphyseal lesions. The disease of one of these, who was seen at the age of 30 years, had begun at the age of seven years with metaphysitis of the tibia. Drainage had been instituted late. Untoward developments were as follows: secondary infection of a knee and apparently subsequent involvement of the corresponding medial femoral epiphysis; resulting genu valgum deformity and increase in length of  $1\frac{1}{2}$  inch (4 cm.).

The second patient, aged 13 years, was seen at the time of onset and presented osteomyelitis of the proximal end of one humerus. Drainage was instituted. Results were closure of the epiphyseal line, continued growth of the epiphysis of the greater tuberosity and increase in the angulation of the surgical neck of the humerus. In addition, there was acute epiphysitis involving one hip joint; this resulted in closure of the epiphyseal line, destructive changes in the epiphysis and ankylosis. Surgical drainage was not instituted.

*Lower Fibular Epiphysis.* In this group of two cases the best end result of epiphyseal involvement of a long bone was encountered. One patient, aged 13 years, whose symptoms were of short duration, had been subjected to drainage of a superficial abscess on the twentieth day after onset of symptoms. The second patient, aged 12 years, was subjected to drainage of a soft tissue abscess on the eighth day after onset of symptoms. Both of these patients presented destructive changes in the lower epiphysis and diaphysis of one of the fibulas, with resulting complete reformation of the epiphysis. In the latter case, at the end

of five weeks, roentgenologic examination (Fig. 7A) gave evidence of destructive changes in the diaphysis and epiphysis, with associated involvement of corresponding tibial epiphysis. Roentgenologic examination at the end of ten weeks disclosed involvement of the entire shaft of the fibula; apparently, also, there was a lesion in the corresponding lower tibial epiphysis and epiphyseal line. Roentgenologic examination at the ninth month gave evidence of regenerative changes in the fibular epiphysis and of healing of the lesion in the tibial epiphysis. At the end of fourteen months roentgenologic examination gave evidence of regeneration of the fibular epiphysis and there was no residual evidence of the lesion of the tibial epiphysis. (Fig. 7B.)

In addition to the case just reviewed in which healing of an epiphyseal lesion was evidenced both by clinical and by roentgenologic examination before the age of 13 years, in two cases which were studied but were not included in the series, there was involvement of one epiphyseal line of a femur with complete healing and no residual deformity or changes in length. One of the patients, aged 9 years, was found to have a lesion involving the lower epiphyseal line of one femur but, on examination seven years later, changes in the epiphyseal line were not disclosed. On the other hand, chronic osteomyelitis was present in the middle third of the shaft of the femur. In the second case, that of a patient, also aged 9 years, whose symptoms had endured for one year, roentgenologic examination gave evidence of involvement of the metaphysis and lower femoral epiphysis on one side, with absorption of the medial femoral epiphyseal line. The epiphyseal line appeared to be fused in its central portion. Five years later there was no deformity or change in length of the affected extremity as compared with the opposite extremity.

*Acetabular Epiphysis.* In this series, two patients, aged 11 and 12 years respectively, presented destructive changes of the acetabulum on one side. The illness of the former patient had existed two years and



that of the latter patient, four months. The acetabulum of the patient whose illness had endured two years had elongated. There



FIG 8 Result of acute acetabular epiphysitis, destructive changes in acetabulum with closure of epiphysis

had been drainage at the end of eighteen months in this case, but in neither of the two cases was there roentgenologic evidence of change in the corresponding proximal femoral epiphysis. In both cases the epiphysis of the affected acetabulum was closed. (Fig. 8.)

*Distal Radial Epiphysis.* In one case a lower radial epiphysis was involved. The patient was 15 years old and the duration of the condition was two and one-half years. Incision and drainage had been effected early in the course of the disease. Besides a lesion in the epiphysis, there was involvement of the diaphysis and epiphyseal line. However, the deformity and evidence of fusion of the epiphyseal line were lacking. The cartilage of the epiphyseal line was of increased density.

*Metacarpal and Phalangeal Epiphyses.* This group is composed of two cases. In the first case, in which there were multiple osteomyelitic lesions, the epiphysis of the middle phalanx of the third finger was involved and there was associated osteomyelitis of the proximal phalanx. The lesion in the shaft of the middle phalanx resembled a cyst. The adjacent portion of the epiphysis also presented the characteristics of absorp-

tion and apparently the lesion in the shaft was continuous with the lesion in the epiphysis. There was associated narrowing of the proximal interphalangeal joint.

In the second case, there were also multiple osteomyelitic lesions, involvement of the epiphysis of a first metacarpal and associated deviating deformity of the thumb of the same hand.

In neither case was a surgical procedure carried out. In the second case, there was associated involvement of the proximal epiphysis of the corresponding humerus; this has been described previously.

#### COMMENT

The occurrence of epiphyseal changes associated with infections of long bones is rare, except in those cases in which surgical trauma to the epiphysis results from incision and drainage. The exception to this statement is the occurrence of epiphysitis in the proximal femoral epiphysis, the distal femoral epiphysis and possibly the distal humeral epiphysis. Usually the epiphysitis occurs in these situations because the epiphysis is anatomically included in the joint.

The occurrence of epiphysitis in structures other than those which enter into the formation of a joint and other than those which are not traumatized in the course of surgical operation, probably results from trauma to the epiphyseal disc or epiphyseal plate before the onset of acute symptoms; that is, probably the region of the metaphysis is traumatized and the associated epiphyseal cartilage is injured; metaphysitis develops and the traumatized cartilage undergoes degenerative changes and may be subjected to infection by direct extension. Another possible source of epiphyseal change is stimulation or irritation from a sequestrum lying adjacent to changes in the epiphyseal line.

Involvement of an epiphyseal line and adjacent epiphysis may undergo healing without residual deformity or change; on subsequent roentgenologic examination the epiphysis and epiphyseal line may appear normal and there may be no clinical evi-

dence of disturbance of growth. Also, lesions in the epiphysis may remain over a long period without destructive or deforming changes; in the presence of lesions of this type the conclusion must be that the cause of the condition is blood-borne infection, organisms being deposited in the epiphysis with resulting degeneration and absorption.

Involvement of the epiphyseal line may result in one of two conditions. The first of these may be a process of absorption, resulting in partial or complete closure, and it is in this type of involvement that shortening and deformity usually result. In the presence of the second type of involvement, roentgenologic examination gives evidence that the epiphyseal line is of increased density and is broader than normal. This results from deposition of calcium in the cartilaginous disc. Deviation deformity is not usually associated with this type of epiphyseal change; lengthening of the bone commonly occurs. However, it should be stated that lengthening of an involved bone may result from hyperemia, although clinical or roentgenologic evidence of epiphyseal involvement cannot be demonstrated during the course of infection and the period of healing.

From roentgenologic evidence in two cases of this series it was apparent that in each a fibular epiphysis was involved and regeneration subsequently took place. Such behavior of an epiphysis of any other bone was not seen and it is barely possible that the absorptive changes may have resulted from hyperemia in association with the inflammatory process. However, this was not considered probable since the epiphyseal cartilage appeared to be absorbed and the avascular plate should not be associated in an osteoporotic process. In conjunction with this observation it was also interesting to note that in two cases in which pathologic dislocation of a hip resulted from acute epiphysitis, the usual destructive changes of the epiphysis were not found. Furthermore, in one case of acute epiphysitis of a proximal femoral epiphysis in

which treatment consisted of five weeks of traction and of application of a cast, without incision or drainage, there occurred very slight destructive change in the epiphysis and subsequently ankylosis occurred with the extremity in good functional position. On the basis of the observation of regeneration of fibular epiphysis in two cases, of diminished or absent destruction of the femoral epiphysis with dislocation of the hip, in two cases, and of preservation of the epiphysis in one case in which treatment was by traction, it is suggested that pressure may play some part in the amount of destruction and absorption of an epiphysis.

In regard to the proximal femoral lesions, it was concluded that if treatment was conservative, that is, if early incision and drainage were omitted, but immobilization and traction were employed and ankylosis resulted, the best clinical end results were attained.

In regard to the tibial epiphysis, it is strongly suggested that epiphyseal changes result from surgical insult at the time of surgical drainage. However, changes may occur in those cases in which the tibial epiphysis is included in the knee joint. This view is supported by Johnston (1936); he reported complete or incomplete interruption of growth in 55.5 per cent of his series of cases in which treatment consisted of making multiple drill holes in the metaphysis, the holes extending to the diaphyseal side of the epiphyseal line.

It was shown further that the epiphysis may make marked physiologic response in an attempt to minimize or prevent deformity. This response takes the form of increased growth or hypertrophy of a portion of an epiphysis.

In two cases there was an unusual response of the talus in an attempt to fill in and occupy a lower tibial defect which had resulted from complete absorption of part of the lower tibial epiphysis. In both cases there was a calcaneal deformity of the foot.

The epiphysis may act as a sequestrum, although this is rare. If it does act thus,

surgical removal of the sequestrum is required.

In the course of acute metaphysitis the surgeon should guard against mistaking associated synovitis of the joint for primary suppurative arthritis. Drainage of such a joint may cause suppurative arthritis to develop, primarily or secondarily, from the

metaphyseal focus and epiphyseal changes may result.

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CONGENITAL affections of the knee are mainly connected with the patella, which is sometimes absent, and then other deformities are associated with its non-development.

# URETEROCELE

## TREATMENT BY TRANSURETHRAL RESECTION

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**U**RETEROCELE is not an uncommon finding in urologic practice.

The term applies to cystic dilations of the intramural portion of the ureter protruding into the bladder, which are the end result of either acquired or congenital partial occlusion of the ureteral orifice. It is to be distinguished from the uncommon prolapse of the ureter through the ureteral orifice, for in the latter the intravesical covering of the mass is ureteral mucosa, while bladder mucosa covers the intravesical portion of the ureterocele. All degrees of dilatation are encountered, from the very small, almost insignificant, lesions to huge sacs filling much or all of the bladder.

The recent contributions of Gutierrez, Vermooten, Lazarus, Huth, Rhodes, Hunner, Foley, Riba, Gibson, O'Connor and Johnson, and Dawley, among others, adequately review the rather extensive literature upon this subject and include comprehensive discussions of the etiology, anatomy, pathology, symptomatology and treatment. It would seem superfluous to present a repetition of these many excellent articles. Only a brief review of the subject, pertaining particularly to etiology and treatment, will be attempted. The accompanying case report seems of interest because of the excellent postoperative end results obtained through the use of a new type of transurethral treatment. This procedure is described.

*Pathology.* A ureterocele is usually a thin-walled, intravesical, cystic dilatation of the intramural portion of the ureter, and as such is composed of bladder mucosa on the vesical side and of ureteral wall on the inner side. Varying amounts of muscle and fibrous tissue are present. If infection exists,

or if excessive fibrous or muscle tissue is present, the cyst wall appears thickened and opaque instead of thin, translucent and easily punctured. The cysts may vary from very small, insignificant structures to very large cysts filling the bladder. Occasionally the large cysts produce urinary retention by obstructing the vesical neck, and if extruded through the urethra they may become strangulated. The degree of ureteral and renal pathology encountered may range from little to severe damage accompanied by advanced hydroureter and hydronephrosis due to the obstruction and back pressure. In late cases, the musculature of the bladder about the ureter, which forms the intramural portion, is frequently damaged by the dilation to the extent that the ureterovesical valve is no longer competent and ureteral reflux occurs after the ureterocele is removed.

*Symptomatology.* Symptoms of ureterocele pertain to the upper urinary tract due to obstruction of the terminal ureter, and to the bladder as a result of either urethral obstruction by large cysts or secondary cystitis. Ureteral obstruction usually causes periodic, dull, aching pains in the loin, although occasionally they may be colicky in nature. These symptoms are similar to and not distinguishable from those noted in other types of ureteral obstruction. Usually the patient endures the mild symptoms, but when severe symptoms incident to superimposed infection occur later, he seeks relief. Vesical symptoms are usually due to secondary cystitis, but acute urinary retention due to prolapse of the cyst into the urethra may occur.

*Incidence.* Ureterocele occurs most commonly in women, usually on the left side.

Bilateral involvement is seen in 10 to 15 per cent of cases. Age is not a factor in its development, for cases have been reported in the stillborn as well as in patients in their seventh decade. In most instances, however, the patient is from 30 to 35 years of age. A detailed urologic history will point to ureteral obstruction earlier in life, and with recent developments in pediatric urology, many more of these anomalies will be diagnosed in infants and children. Campbell reports encountering ureterocele in nineteen children in a group of 580 with persistent pyuria.

*Etiology.* There is some divergence of opinion as to the cause of ureterocele, but the almost universal finding of stenosis of the ureteral orifice suggests this as a major contributing factor. There is little to substantiate Petillo's belief that the essential factor is paralysis and subsequent atony with dilatation of the terminal ureter. The theory of congenital ureteral obstruction is supported most ably by Chwalle and Brown. In the embryo, the ureter shifts its attachment from the Wolffian duct to the bladder. Chwalle has shown that in all human embryos of 12 to 28 mm. there is a brief period of atresia of the ureteral lumen at the bladder wall following the establishment of this new connection. The epithelium overlying the lumen then becomes thinner, bulges toward the bladder and finally ruptures, establishing patency of the ureter. Vermooten points out that if the pressure on the membrane does not cause it to slough and allow the escape of the fluid as a result of the active functioning of the metanephros, we must assume that a hydronephrosis and hydroureter will develop. That this hydronephrosis does develop is shown by Brown, who found a high percentage of mouse embryos, in a strain of mice, to have deformed or abnormal kidneys. She found that the hydronephrosis was produced by a developmental stricture of one or both ureters at their junction with the bladder. The condition was first noted at the seventeen day stage. In ten of a group of twelve embryos, the pelvis and the

upper fourth of the ureter were greatly distended by fluid. The ureters, however, narrowed down to their junction with the bladder, where the muscular wall of the bladder appeared to form a stricture. Among the nineteen and twenty day embryos, she found three cases of definite hydronephrosis due to stricture of the ureter just before it entered the bladder. Vermooten points out that if the membrane occluding the ureter only partially breaks down, either a congenital valve, a ureterocele, or a stricture at or just above the ureterovesical junction develops.

These facts support the congenital theory of ureterocele formation, which is further emphasized by the fact that definite ureteroceles have been demonstrated in the newborn and occur frequently in association with other developmental anomalies. There is, however, no reason to believe that stricture or stenosis of the ureteral meatus may not be acquired in some instances as a result of inflammation.

*Diagnosis.* There are no pathognomonic signs or symptoms of ureterocele. The symptoms and findings may suggest pyelonephritis, stone or tumor. Diagnosis is dependent upon cystoscopy, although the characteristic appearance of a dilated lower ureter protruding into the bladder, noted in excretory urograms, may be highly suggestive. Early investigation of recurrent or chronic persistent pyuria in infants and children will allow many more of these lesions to be treated early, while there is less secondary renal and ureteral pathology. Cystoscopic examination in early cases shows a small pea-size cystic dilatation with a small orifice on its surface representing the stenosed ureteral orifice. In larger lesions, the orifice may be displaced in any direction. The cyst wall appears thin and translucent with well-defined vessels, although when infection is present, or in the rare, thick-walled cyst containing fibrous and muscle tissue between the two mucous layers, the wall appears thick and opaque. While observing the ureterocele through the cystoscope, one sees with each peristal-

tic rush of urine, a ballooning-up of the cyst followed by efflux from the stenosed orifice and collapse of the cyst. Frequently the ureteral orifice cannot be entered with anything but the smallest catheter. Search should be made for more than one orifice, for many cases of ureterocele are accompanied by reduplication of the ureter on the corresponding side. Retrograde or excretory urograms and renal function tests are important in estimating the condition of the upper urinary tract.

*Treatment.* Treatment depends upon the stage of evolution of the ureterocele, the presence or absence of complications, and the degree of renal and ureteral damage. Types of treatment are divided into surgical and urologic.

All treatment directed to the ureterocele per se is concerned with two objectives: first, to remove the obstruction at the terminal ureter; and second, to preserve the integrity of the ureterovesical valve. Many reports of otherwise successful operations, particularly those involving open surgery with resection of the ureterocele, state that the patient has been left with ureteral reflux, sometimes necessitating nephrectomy later. It is hardly necessary to point out that nothing can be accomplished in restoring competency of the ureteral valve by any transurethral procedure. Therefore, it would seem of immediate importance in treating ureterocele to estimate competency of the ureteral valve by all available pre-operative means.

If the valve is incompetent, the procedure of choice is either cystotomy with removal of the cyst and repair of the aperture in the bladder wall in an attempt to restore ureteral valve competency, or immediate nephroureterectomy. It is beyond the scope of this paper to deal with these phases of the subject. Nephroureterectomy has been adequately described by Gibson. Young's operative procedure of bringing together the musculature of the bladder with a purse-string suture to repair the bladder wall, reported by him in 1912, was among the first of such reports. However, it

is probably safe to say that when obstruction has been of such persistence and long standing that the intramural portion of the ureter is grossly dilated, the ureter and kidney will also be severely damaged, and it is wiser to elect nephroureterectomy at the start.

I agree with Petillo and Hunner who say ablation through suprapubic cystotomy, still advocated by many surgeons, is to be considered a surgical abuse, unless for special reasons it should be absolutely necessary. As an exception to this rule, one might consider the rare case of well advanced ureterocele with incompetent ureterovesical valve where sufficient good functioning renal tissue is present to warrant its conservation. Other exceptions would be the very large ureteroceles filling the bladder and causing urinary retention, or those extruding through the urethral orifice as reported by Kuth, Herick and Davis and Owens, in which cases the suprapubic approach might be indicated.

When the ureterocele is very small and almost insignificant in size, dilatation of the meatus with ureteral bougies and catheters, and irrigations of the renal pelvis and ureter at ten-day intervals are frequently sufficient to establish and maintain good drainage.

In the development of the larger ureteroceles, it must be kept in mind that as a result of increased ureteral pressure due to meatal obstruction, dilatation of the lower portion of the intramural segment of the ureter occurs. As it progresses in size, it strips the mucosa up from the musculature of the bladder but does not involve it with its sphincter-like action until later. Therefore, competency of the ureterovesical valve remains. This is better understood when one considers Gruber's illuminating work, showing that three-fourths of a dog's ureteral valve may be completely cut away without signs of regurgitation, even under extreme pressure. In defending the procedure of ureteral meatotomy in general, Moore reports its use favorably in cases of ureterocele. He states that the complication

most to be feared following meatotomy is regurgitation of urine from the bladder up the ureter, and reports this as occurring



FIG. 1. Preoperative excretory urogram, showing double renal pelvis and ureter, and moderate pyelectasis and ureterectasis. Good excretion of the contrast medium evident.

rarely in his experience. It would seem that if treatment is undertaken in the early stages of ureterocele development, before much dilatation of the intramural portion of the ureter has occurred, simple opening of the cyst, either at the meatus or elsewhere, should suffice to eliminate obstruction of the stenosed ureteral orifice, and should permit the ureter to drain freely into the bladder through a competent ureterovesical valve.

It is only of academic interest to consider the various methods with which transurethral opening of the ureterocele may be accomplished. Any method which establishes a good opening should suffice. The meatotomy can be accomplished with the cold cutting scissors or with the high frequency cutting current applied by an electrode. Special types of electrodes have been devised primarily for this purpose by Moore and Riba. If the ureteral orifice is difficult to see or enter, the cyst may be opened elsewhere.

Removal of the redundant portion of the cyst wall seems unnecessary although partial removal in the very large ureteroceles might be of advantage. Various authors report attacking ureteroceles through the cystoscope with the cautery loop, scissors, a small knife, cystoscopic rongeur, a combination of knife and punch force, or by fulguration. Riba points out that if the ureterocele is of a non-collapsible type, transurethral resection with the McCarthy electrotome is the treatment of choice and has used it in two of his cases. Gutierrez mentions the loop electrode method of treatment for endoscopic prostatic resection but has used it in none of his eighteen cases. These are the only references to this particular procedure in the literature of which I am aware.

*Procedure.* It would seem of interest to point out that most ureteroceles may be adequately dealt with by resection of a portion of the wall with the McCarthy electrotome which is now in such common usage. All but the very small and the very large ureteroceles are susceptible. A general anesthetic is necessary, preferably low spinal or intravenous. High intravesical pressure when the bladder is overdistended prevents ballooning of the ureterocele, so that a little or moderate distention after introduction of the instrument allows better visualization of the ureterocele. If the ureterocele is of the uncommon, thick-walled, non-collapsible variety, no difficulty will be experienced in resecting a large piece of tissue with the loop electrode. Some of the redundant wall may be resected if thought desirable. Fulguration adequately controls any bleeding which occurs. In the thin-walled, collapsible ureterocele, maximum ballooning must be watched for and at the precise moment it occurs resection should be carried out. This is followed immediately by collapse of the cyst and retraction of its wall; further resection of the wall is dangerous and unnecessary. The site selected for resection should be the most prominent portion of the cyst. If the ureterocele is sufficiently distended, there is

no danger of injuring or penetrating the musculature of the bladder beyond the bladder and ureteral mucosa comprising

Examination disclosed a reddened pharynx, some tenderness across the entire lower abdomen and slight tenderness in each kidney re-



FIG. 2. Cystoscopic appearance of ureterocele. A, ureterocele distended; B, ureterocele collapsed.

the cyst wall. The muscular bladder wall and intramural portion of the ureter are left intact. If the ureterovesical valve is competent, reflex will not occur. The redundant ureterocele wall shrinks, the raw surface of the bladder epithelializes and good ultimate repair occurs. Insertion of a retention ureteral catheter prevents possible ureteral obstruction incident to post-operative edema and a retention urethral catheter obviates possible harmful bladder distention. The ureteral catheter should be removed in two to four days, while the urethral catheter may be left for a longer time if desirable.

#### CASE REPORT

Mrs. L. C., age 29, was admitted to the medical department of the University Hospital August 16, 1938. She complained of nausea, vomiting, chills, fever and dysuria. Two weeks prior to admission, the patient had "septic sore throat" lasting four days, after which she was well for two days and then had nausea and vomiting and, later, chills and fever. Burning on urination had been severe for five days before admission. Suprapubic and low back pain occurred one day before admission. The patient had had a normal child two months prior to admission. No part of the history suggested previous urinary infection or pathology.

gion, more noticeable on the left side. The urine was loaded with pus cells and contained many red blood cells. Flexner dysentery bacilli were cultured from the urine. Agglutinations for dysentery were positive in dilution 1:320.

Sulfanilamide in large doses caused rapid clearing of the urine and a drop in temperature

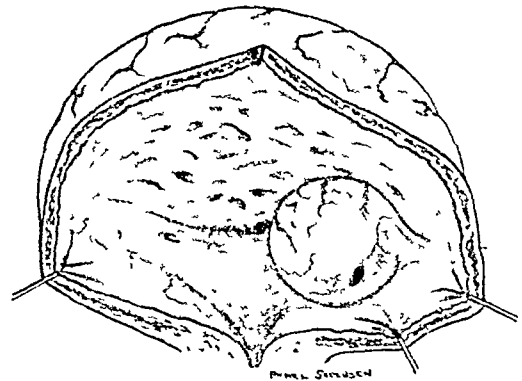


FIG. 3. Gross appearance of left ureterocele. Only one ureteral orifice seen.

from 105 on admission to normal five days later. The drug, however, caused marked cyanosis, the hemoglobin dropped to 65 per cent, and the erythrocytes to 3,230,000 six days after admission. Therefore, it was discontinued. On August 24, a transfusion of 375 c.c. of citrated blood was given. The patient did well until September 4, when the temperature suddenly rose from normal to 105, accompanied by a chill. She could not tolerate sulfanilamide at this time,



although it was tried for a few days, with no appreciable effect on the pyuria and fever.

The excretory urograms made on Septem-

ber 1, (Fig. 1) showed a slightly enlarged left kidney, double left ureter and renal pelvis, and moderate pyelectasis and ureterectasis. There was good excretion of the contrast media by each kidney.



FIG. 4. Preoperative retrograde pyeloureterogram showing marked dilatation of the inferior left renal pelvis, and associated ureter down to its junction with the bladder. The upper pelvis has not been filled with contrast medium. Ureterocele not demonstrated.

ber 1, (Fig. 1) showed a slightly enlarged left kidney, double left ureter and renal pelvis, and moderate pyelectasis and ureterectasis. There was good excretion of the contrast media by each kidney.

Urologic consultation was requested on September 7. There was marked tenderness in the left costovertebral area but the left kidney was not palpably enlarged. Observation cystoscopy on September 8 showed a normal right ureteral orifice and a left ureterocele, which alternately filled (Fig. 2A) and collapsed (Fig. 2B) in association with ureteral peristalsis. When full, the cyst was about the size of an English walnut. (Fig. 3.) Only one ureteral orifice was seen on the left side. A No. 6 catheter was passed easily, relieving the left flank pain instantly; 75 c.c. of hazy urine was aspirated from the left renal pelvis.

Phenolsulphonephthalein appeared in six minutes from each ureteral catheter after intramuscular injection and 5 per cent was recovered in ten minutes from the right side, none from the left. Bilateral pyeloureterograms were obtained by injecting 30 c.c. of contrast media on the left and 5 c.c. on the right side. A No. 6

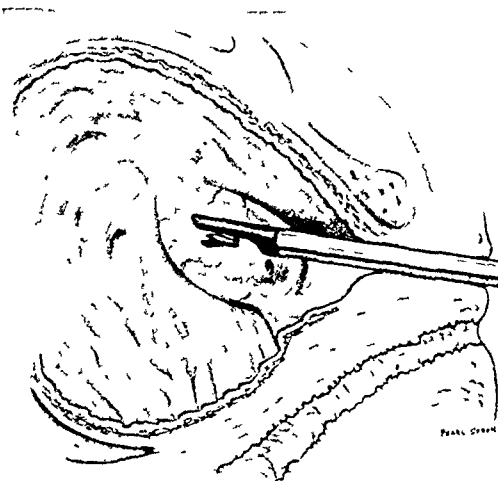


FIG. 5. Removing a large piece of ureterocele wall with the McCarthy electrotome. Site elected for resection is located over the most prominent portion of the ureterocele at a time when the cyst is fully distended.

left flank was relieved. Chills and fever were again noted on September 21, at which time another retention left ureteral catheter was inserted and again pain and fever rapidly subsided. No further urinary antiseptics were given, but an autogenous vaccine made from cultures of the urine was given from September 10 to September 18.

The retrograde pyelograms (Fig. 4) showed marked dilatation of the inferior left renal pelvis and the associated left ureter down to its junction with the bladder. The ureterocele was not demonstrated.

On September 24, under spinal anesthesia (50 mg. novocaine), one large piece of tissue was removed from the most prominent portion of the ureterocele with the McCarthy resectoscope. (Fig. 5.) This tissue was removed at the time the ureterocele was seen to be fully distended. The ureterocele collapsed immediately. A No. 6 ureteral catheter was passed through this new opening into the left ureter where it was left for continuous drainage.

No postoperative reaction occurred. There was no elevation in temperature and the patient was entirely relieved of all left renal pain. The retention ureteral catheter was removed on the third postoperative day. The urine was clear on numerous examinations during her postoperative stay and the cultures were sterile. The

patient was transferred from the urologic service on October 2, the eighth postoperative day, to the psychiatric department because of toxic

admitted a No. 6 ureteral catheter readily, the lower one passing to the upper pelvis, as would be expected. Urine from each left catheter

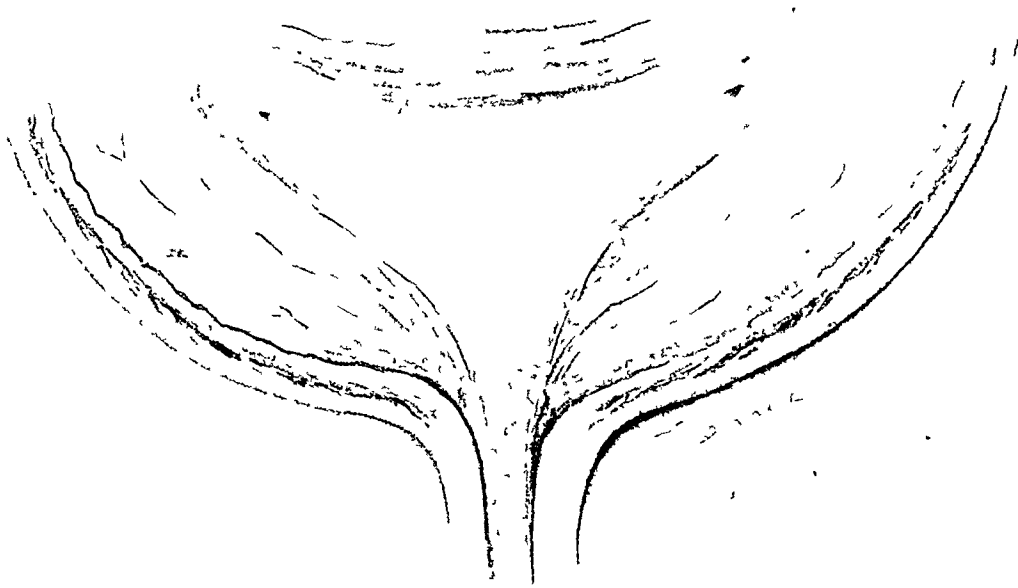


FIG. 6. Postoperative cystoscopic appearance of left ureteral orifices ten months after transurethral resection. Two orifices were seen, the upper slightly smaller and the lower slightly larger than normal.

psychosis. Her mental condition rapidly improved and she was dismissed from the hospital, well, on October 16, 1938.

The pathologic examination of the tissue removed at operation showed it to be covered with transitional epithelium. There were some strands of smooth muscle fibers in the wall.

This patient returned to the University Hospital on August 3, 1939, because of headaches and indefinite gastrointestinal symptoms. She complained also of occasional pain in the left flank when her bladder was overdistended. This suggested possible ureteral reflux. The left kidney was not tender or palpable. Cultures of the bladder urine showed *B. coli communis* and microscopic examination showed fifteen to twenty pus cells per high power field. The non-protein nitrogen was 33.0 mg. per cent.

Observation cystoscopy showed two left ureteral orifices at this time, the lower one being slightly larger and the upper slightly smaller than normal. (Fig. 6.) Each orifice

showed appearance of phenolsulphonephthalein in five minutes after intravenous injection; 2.5 per cent was recovered from the upper and 1 per cent from the lower pelvis in ten minutes after appearance of the dye. Microscopic examination of the urine from the upper pelvis showed only a few pus cells and from the lower only five to eight pus cells. Culture of the urine from the upper pelvis was negative and from the lower showed *alkalinis aerogenes*. The retrograde pyelograms at this time (Fig. 7) indicated regression in size of the two left renal pelves and ureters although there was still some pyelectasis and ureterectasis. The cystogram indicated no x-ray evidence of ureteral reflux. The patient was discharged from the hospital after two weeks' observation, entirely free of symptoms.

#### COMMENT

Apparently this patient had no symptoms referable to the bladder or the left

upper urinary tract until a hematogenous urinary infection occurred incident to "septic sore throat." This seems to be the usual

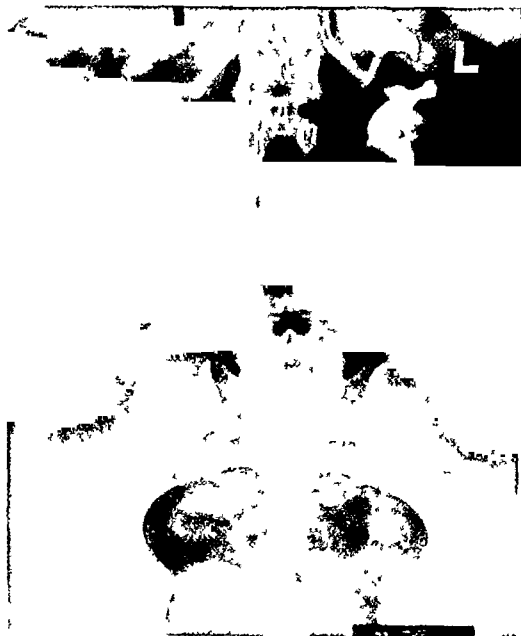


FIG. 7. Postoperative retrograde pyeloureterogram ten months after transurethral resection, showing definite regression in size of the left ureters and renal pelvis indicating improved drainage although some pyelectasis and ureterectasis persists.

story, although as pointed out by Hunner, minor symptoms of ureteral obstruction should be elicited by careful history if the patient comes under observation prior to the onset of infection. The fact that an indwelling ureteral catheter caused prompt regression of symptoms emphasizes the importance of drainage in these cases. In spite of the well advanced hydroureter and hydronephrosis, accompanied by marked impairment of renal function, relief of obstruction caused regression of the dilatation and return of much function. Infection was practically eliminated, as were the patient's symptoms. In spite of apparent moderate dilatation of the lower ureter preoperatively, the ureterovesical valve remained competent as demonstrated postoperatively by absence of ureteral reflux in the cystogram. Simple transurethral resection of a portion of the ureterocele wall without removal of the redundant portion of the cyst

caused no postoperative reaction, produced good ureteral drainage, and maintained competency of the ureterovesical valve. It seems that a large majority of ureteroceles would be amenable to such surgical attack. The appearance of the bladder one year following operation indicated excellent repair and good end result. The lower left orifice probably represented the new opening established by resection. The small upper left ureter readily admitted a No. 6 ureteral catheter. Reduplication of the ureters in this case further emphasizes the dictum that when one congenital anomaly of the urinary tract is encountered, others should be suspected.

#### SUMMARY

1. The most probable developmental cause of ureterocele is discussed.
2. Early recognition of ureterocele by complete urologic investigation of recurrent or persistent pyuria in children is emphasized.
3. Various methods of treatment of ureteroceles are considered and the suggestion is made that many are amenable to simple transurethral resection of a portion of the wall with an electrotome.
4. One case of ureterocele, with reduplication of the ureter and pelvis, treated by transurethral resection is reported.\*

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# TREATMENT OF FURUNCLES, CARBUNCLES AND ABSCESES OF STAPHYLOCOCCIC ORIGIN WITH THIAZOLE DERIVATIVES OF SULFANILAMIDE

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SINCE Gelmo<sup>5</sup> synthesized para-amino-benzene-sulfonamide in 1908; numerous variations have been developed. None have been both effective against staphylococci and innocuous to the host. This has also been true of other compounds not related to sulfanilamide or to the azo dyes. In 1939, a new series of derivatives was announced by Fosbinder and Walter<sup>4</sup> and subsequently by Lott and Bergeim.<sup>9</sup> Among them were 2 (para-amino-benzene-sulfonamido) thiazole and its methylated derivative, 2 (para-amino-benzene-sulfonamido) 4-methylthiazole. They are more commonly known by the names sulfathiazole and sulfamethylthiazole, respectively.\*

Preliminary studies<sup>1,6,10,12</sup> on animals and on humans seemed to indicate that the thiazoles were not more toxic than sulfapyridine and had a more profound effect against staphylococci. Since sulfamethylthiazole appeared to be the most potent in this respect, one of us (C.A.B) undertook an investigation of the use of the drug for acute staphylococcic infections that are frequently fatal. During the investigation the collaboration of the coauthor (A. R. A.) resulted in this paper concerning the less severe staphylococcic infections.

The initial study showed that sulfamethylthiazole was more effective against staphylococci in vivo than sulfapyridine, and that the reactions produced by the former were fewer and less severe. The drug was given, therefore, to hospitalized patients with milder staphylococcic infections, including furuncles and abscesses. Our experience with sulfamethylthiazole was encouraging and indicated that it was not a

dangerous drug in nearly fifty cases of various types to which it was administered in various forms. Other investigators observed peripheral neuritis in several cases<sup>7</sup> and the condition was confined almost exclusively to ambulatory patients. Since no neuritis has been reported in patients with pneumococcal pneumonia treated with sulfathiazole<sup>3</sup> we considered that it was safe to use sulfathiazole for ambulatory patients with furunculosis.

This communication is limited to forty cases of staphylococcic infections. They were not selected, but were taken as they were admitted for hospitalization or presented themselves in surgical clinics for treatment. There were thirteen patients with carbuncles, twelve with furuncles, and fifteen with abscesses. Twenty-five patients received sulfamethylthiazole and the remaining fifteen sulfathiazole. Staphylococci were cultured from the lesions in each patient and were recovered from the blood stream of one. All determinations of the level of the drugs in the blood, urine and feces were done according to the method of Bratton and Marshall.<sup>2</sup>

## ADMINISTRATION AND DOSAGE

The methods of administration and the dosage were the same for both drugs. Half-gram (7½ grain) tablets were given whole or powdered and suspended in milk or condensed-milk and milk in about equal proportions. These seemed to be the most satisfactory when a suspending medium was required. The earlier patients received sulfamethylthiazole in powdered form made up into ½ Gm. capsules. The first few

\* The sulfamethylthiazole and sulfathiazole were supplied to us by the Department of Medical Research of the Winthrop Chemical Company.

adults were given an initial dose of 3 Gm. followed by 2 Gm. every four hours day and night. We found that this dose was larger than necessary and reduced it to 1 Gm. every four hours. The level of free drug in the blood reaches as high as 11 mg. per cent when the larger dose is used, with an average around 8 mg. per cent. With the 1 Gm. dose the concentration of free drug is usually around 4 mg. per cent and any concentration above 3 mg. per cent seems to be adequate for the types of cases herein reported. If the dose is reduced to below 1 Gm. every four hours, much of the effect is lost. We now give the average adult an initial dose of 2 Gm. followed by 1 Gm. every four hours, omitting the 4 A.M. medication after forty-eight hours. A total of 5 to 6 Gm. is received daily (75 to 50 grains). Children are given 0.5 Gm. per twenty-five pounds of body weight to start with and a maintenance dose of 0.25 Gm. per twenty-five pounds every four hours, both calculated to the nearest  $\frac{1}{2}$  Gm. It may often be necessary to increase the dosage to maintain a free drug blood level that is at all satisfactory. Children apparently eliminate the thiazoles rapidly and tolerate them very well.

Two patients were given rectal instillations of the drug. One received sulfamethylthiazole and the other, sulfathiazole. The first required rectal administration because of extreme nausea and vomiting. She maintained a blood level of at least 0.15 mg. per cent while taking 2 Gm. every four hours by rectum. The other patient received sulfathiazole by rectum for two days because she refused to take it by mouth after experiencing slight nausea. She tired of the rectal feedings and returned to the usual methods after two days without further nausea. None of the patients were sufficiently ill to require immediate creation of an adequate blood level by giving the sodium salts intravenously.

#### ABSORPTION AND EXCRETION

Absorption of the thiazoles from the human gastrointestinal tract must depend

upon a number of factors which include the rapidity of passage of the material through the tract and the condition of the mucous membranes of the various portions of the tract with regard to their power of absorption at the time. Individual variations in blood level obtained from the same oral dosages demonstrate this. The absorption rate must, therefore, be calculated from the sodium salts which are more uniformly absorbed. This is not practical for clinical purposes. As stated in the preceding section, an initial dose of 2 Gm. followed by 1 Gm. every four hours will usually result in a blood level of free drug in adults of about 4.0 mg. per cent, and almost always in a level above 2.9 mg. per cent. Absorption continues with larger doses and it is possible to cause a rise in blood level to over 20 mg. per cent.

Sulfathiazole and sulfamethylthiazole exist in the blood stream in free and conjugated or acetylated forms. The amount of conjugated sulfathiazole or sulfamethylthiazole is usually low in relation to the free drug. The proportion of conjugated drug is relatively high in the urine and very low in the stools. Analysis of the tables compiled by Reinhold, Flippin and Schwartz<sup>11</sup> from patients with pneumonia given repeated doses of sulfathiazole reveals that 25 per cent of the total drug in the blood is in conjugated form, taken as a grand average with maximum deviations to 2 per cent and 70 per cent. The average ratio of sulfathiazole to acetylsulfathiazole is, therefore, three to one. It is a fairly constant ratio except for occasional wider variations.

The blood stream is entirely cleared of the drug, as estimated by the routine tests, in twenty-four to forty-eight hours depending upon the amount of drug in the circulation at the time it is discontinued. Excretion takes place through the kidneys and gastrointestinal tract so that the two forms of the drug may be recovered from the urine and feces. The following table shows the proportion of a 3 Gm. oral dose excreted in twenty-four hours through the several channels.

TOLERATION AND REACTIONS

The chemical nature of the thiazoles and their relationship to the parent sulfanilamide and to sulfapyridine and other derivatives would suggest that side effects

The fact that no patients receiving either of the thiazoles have exhibited reduction in the number of leukocytes either during or after treatment merits special emphasis, particularly in view of the absence of such reaction in the prior series of grave staphy-

WHITE MALE, 41 YEARS, 150 POUNDS

Date	Hour	Blood	Urine	Feces	Combined Excretion	Form
July, 31, 1940.....	9 A.M.	3 Gm.—single oral dose				
	3 P.M.	1.8 mg. %	....	....	.....	Free
	3 P.M.	2.3 mg. %	....	....	.....	Total
August 1, 1940.....	9 A.M.	0.1 mg. %	0.1 Gm.	0.24	.....	Free
	9 A.M.	0.2 mg. %	2.36	0.27	2.57	Total
August 2, 1940.....	9 A.M.	0 mg. %	0.0	0.05	.....	Free
	9 A.M.	0 mg. %	0.2	0.05	0.25	Total
July 31–August 2, 1940.....		Total drug recovered			2.82 Gm.	

might be produced that are similar to those from other compounds used in humans. We were constantly on the watch, therefore, for the appearance of such reactions as anemia, leukopenia, cyanosis, nausea, vomiting, diarrhea, skin rashes, hyperpyrexia, nephritis, hematuria, urinary lithiasis and psychic disturbances.

REACTIONS TO DRUGS

Reaction	Patients Given Sulfamethylthiazole (25)		Patients Given Sulfathiazole (15)	
	No.	Per Cent	No.	Per Cent
Nausea.....	9	35	5	33
Vomiting.....	3	12	2	12
Crystals in urine.....	16	65	1	6
Headache.....	3	12	1	6
Hematuria (micro.).....	2	8	2	12
Skin rash.....	2	8	0	
Weakness.....	1	4	1	6
Anemia.....	2	8	0	

lococcic infections. Two patients that received sulfamethylthiazole evidenced a moderate anemia which rapidly cleared up after discontinuing medication. The appearance of anemia was not considered an indication for withdrawal. Two other patients taking sulfamethylthiazole developed diffuse punctate erythematous rashes on the body and extremities. These rashes disappeared within twenty-four to forty-eight hours although medication was continued.

The majority of patients do not have gastric distress. Others complain of vague discomfort and a loss of desire for food. When nausea occurs, it is usually not accompanied by vomiting and disappears promptly while the dosage is maintained. The development of nausea does not seem to be related to the occurrence of other reactions. It comes on more often when sulfamethylthiazole is given. The 33 per cent incidence of nausea recorded for sulfathiazole is not representative because of the few cases and it has been our experience with a larger series of over fifty patients treated with this drug that nausea is less frequent. One woman who received sulfamethylthiazole was violently nauseated and vomited persistently until it was discontinued. She tolerated it by rectum. Large numbers of crystals were found in the

Because a small series limits justifiable conclusions, the various reactions encountered are listed in their order of frequency and no attempt has been made to set up a statistical analysis.

urine from most of the patients receiving sulfamethylthiazole, while the urine of those taking sulfathiazole rarely contained

that the urea clearance was diminished as much as 50 per cent during sulfathiazole therapy, that it was transitory and that

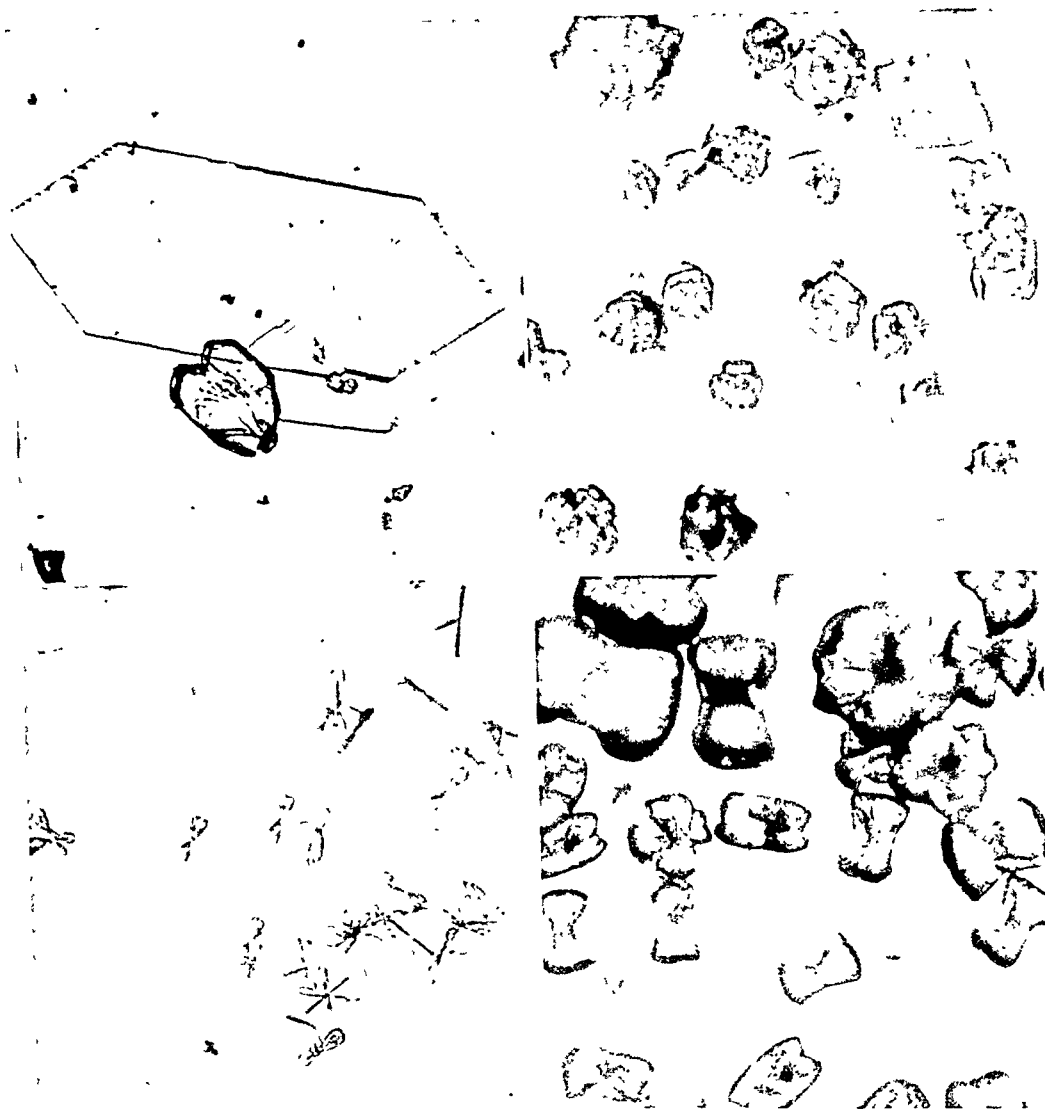


FIG. 1. Upper left: Sulfathiazole crystallized from neutral distilled water. Lower left: Sulfamethylthiazole in urine of treated patient. Upper right: Sulfathiazole dissolved and recrystallized from normal urine. Lower right: Sulfathiazole in urine of treated patient.

them. Red cells and crystals disappeared after medication was discontinued.

The low incidence of reactions of any consequence make sulfathiazole a relatively safe drug for use in ordinary staphylococcal infections. Aside from crystals and slight microscopic hematuria, no other changes in the urine were found. Diminished daily output was not observed. The findings of Reinhold, Flippin and Schwartz<sup>11</sup> in this direction merit attention. They observed

return to normal function occurred without discontinuing the drug. The presence of pneumonia in all the cases and other factors probably enter into the final analysis.

Figure 1 depicts crystals of sulfamethylthiazole and sulfathiazole in the urine. The former are easily mistaken by the laboratory technician for urates and phosphates, and the latter for leucine and tyrosine.

Our patients have tolerated sulfamethylthiazole and sulfathiazole in oral doses of



from 6 to 12 Gm. daily for periods of from one to two and one-half weeks without any apparent cumulative toxic effect.

part upon the stage of development of the lesion when the drug is commenced. We have observed that the earlier furuncles



FIG. 2. O. M. H., No. 56082. Large furuncle of nose. Resolution following spontaneous drainage during three days of sulfamethylthiazole therapy. No drug reaction; 24 Gm. total; blood level, 5.0 mg. per cent.

#### EFFECTS OF TREATMENT

Thirty-eight of the patients were definitely improved after receiving a considerable quantity of sulfamethylthiazole. One result was questionable because of the prolonged course of the disease and concomitant administration of staphylococcus vaccine. Staphylococci were cultured from every patient and in several cases streptococci were found.

Furuncles were affected most readily and disappeared within four days, except in two instances. One patient had about ten furuncles and responded satisfactorily to therapy although eight days elapsed before the last one disappeared. The other patient was not definitely improved and had received vaccine, as mentioned above. The most rapid disappearance of a furuncle occurred in two and one-half days, during which time a large, fiery-red indurated lesion on the nose receded to an almost indistinguishable tinge of redness without induration or edema. (Fig. 2.) It may be said that the length of time taken to respond to thiazole therapy will depend in

respond about 25 per cent more slowly than well developed lesions, but recede without pus formation. The latter quickly soften, discharge their contents promptly and heal. No core forms and the discharge is liquid, quite unlike that of the untreated furuncle. The induration and redness around the lesion disappear rapidly. The relative lack of induration is the most striking feature. After four days of sulfamethylthiazole therapy the drainage from the lesion in Case II became sterile. The original cultures disclosed *Staphylococcus albus*.

**CASE 1.** The patient, a white female, ambulatory, 26 years of age, weighing 136 pounds, was referred by her physician for treatment.

Four days previously, on June 10, she noticed a "deep pimple" on her left cheek. This enlarged and became swollen. The lesion measured 4 cm. in diameter, was red, warm to the touch and fluctuant. Temperature was 99.2°F. Commencing on June 14 she was given sulfathiazole, 1 Gm. every four hours, omitting one dose at 4 A.M. Within twenty-four hours the lesion had softened and had started to drain. The patient complained of nausea, headache and malaise but did not vomit. The blood level

of the free drug was 3.6 mg. per cent. Cultures revealed *Staphylococcus aureus*. On the second day profuse drainage was followed by gradual

not always true as is demonstrated by Case II, which responded in six days. If it is deemed necessary to excise a carbuncle we



FIG. 3. O. M. H., No. 55632, Case 19. Before and after six days of sulfamethylthiazole therapy. Carbuncle of face and diabetes mellitus. Reaction—skin rash. 61 Gm. total; blood level, 5.5 to 9 mg. per cent.

disappearance of redness and induration. The core separated and came away on the third day. Nausea and headache had disappeared. The dose was reduced to 0.5 Gm. every four hours on the third day and medication discontinued on the fifth day. At discharge from the hospital the temperature was normal, the lesion was healing and there was practically no drainage. The urine was normal. The blood count was Hg. 80 per cent red blood count, 4,200,000; white blood count, 6,700; polymorphonuclears, 78 per cent; lymphocytes, 22 per cent. A total of 19 Gm. was given.

Carbuncles respond more slowly because of the extensive nature of the lesion, but do so with relative rapidity and in essentially the same manner. The surrounding infiltrated areas become soft and the redness disappears while the drainage assumes the character described for furuncles. Any cores which may have formed prior to the institution of treatment are very soft and easily dislodged. Diabetes mellitus is not a contraindication to administration of the thiazoles although it may prolong the time required for the lesion to improve. This is

advise giving sulfathiazole for twenty-four hours prior to operation. If immediate surgery is contemplated, sufficient sodium sulfathiazole should be injected intravenously to assure an adequate blood level. We believe that this will tend to prevent the spread of infection from the original site, to prevent the development of septicemia and to insure against residual infection locally. The following two cases are notable for their rapid recovery from carbuncles of the dangerous area of the face. The second patient had a *staphylococcus* bacteremia.

CASE II. O. M. H. No. 55632. A white male, 68 years of age, weighing 182 pounds, had had diabetes for several years.

About two and one-half weeks before admission, he developed a slight swelling on his forehead above the left side of the nose. The lesion gradually increased to involve the eye and cheek of the same side. On admission, February 8, 1940, there was a large, bluish red swelling on the forehead, the eyelids were swollen and bluish and the right eye was entirely closed. The discoloration extended in a

butterfly pattern over the dorsum of the nose and both cheeks. A small amount of yellow pus exuded from several small openings just above

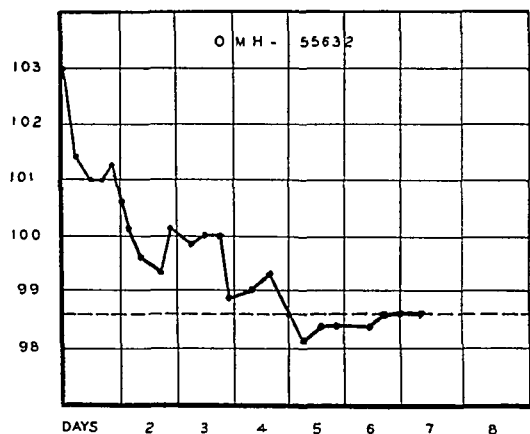


FIG. 4. Temperature chart, Case 2. Same patient as in Figure 3.

the inner canthus of the right eye. It flowed over the eyelid and appeared to be reaching the surface of the eyeball between the swollen lids. The temperature was 103°F., pulse 112, respirations 24. Cultures showed *Staphylococcus albus* and nonhemolytic streptococcus. The urine contained 4 plus sugar, 2 plus albumin, 4 plus acetone, and occasional hyaline casts. The blood culture was negative. The blood count was Hg. 93 per cent; red blood count, 4,860,000; white blood count, 21,500; polymorphonuclears, 86 per cent. The blood sugar was 166 mg. He was given 2 Gm. every four hours night and day. Twenty-four hours later the temperature was 100.6°F., pulse 82, respirations 18. The urine contained 1 plus albumin, 20 to 25 red cells per HPF, and was free of sugar. The white count had dropped to 14,800 with 80 per cent polymorphonuclears. The carbuncle had softened considerably and was drained through a small incision at its most prominent point. Profuse drainage of pus followed. From this point on there was rapid improvement. Drainage was complete in four days. On the third day the temperature and pulse dropped to normal and remained there. The sulfamethylthiazole was reduced to 1 Gm. every four hours on the fifth day and was discontinued on the seventh day. On the eighth day the patient was transferred to the medical ward for diabetic treatment. The free sulfamethylthiazole content of the blood reached 5.5 mg. per cent in twenty-four hours. It gradually increased to 9 mg. per cent on the fifth day and when the dose was reduced it

dropped to 6.6 mg. per cent. The blood count at the close of the treatment was Hg. 91 per cent; red blood count, 4,560,000; white blood count, 8,000; polymorphonuclears, 66 per cent. Red cells were found in his urine on two occasions but disappeared about twenty-four hours after the medication was discontinued. He was not nauseated or cyanotic and did not vomit. On the fourth day a generalized reddish, blotchy skin rash developed that caused some itching, but disappeared in twenty-four hours without interruption in the administration of sulfamethylthiazole. A total of 61 Gm. was given. (Figs. 3 and 4.)

CASE III. St. B. No. 9723. The patient, a white male, 38 years of age, weighing 148 pounds, had had increasing tenderness, redness and swelling of left upper lip for two days followed by fever and intense pain. The lesion spread up the nose to the left eye. It was the third attack in a year, but the first with general symptoms. The lip was greatly swollen and the nose and lower lid were red and edematous. The temperature spiked from 99.0° to 102°F. Blood culture on first day of hospitalization showed *Staphylococcus aureus* hemolyticus. On the third day in hospital sulfamethylthiazole was given—3 Gm., followed by 2 Gm. every four hours day and night. The blood level of free drug ranged between 4.8 mg. per cent to 6.8 mg. per cent during the eleven days he took medication. The lesion rapidly localized and none of the subsequent blood cultures were positive. Seven days after commencing the drug the lesion was localized to a small, red area in the left upper lip. On the twelfth day he complained of weakness in the shoulders and legs. This cleared up in about one week. His urine repeatedly contained many crystals of sulfamethylthiazole. The leukocytes declined from 13,500 to 7,900 in five days. Leukopenia or anemia did not occur. His hemoglobin, however, dropped from around 95 to 70 per cent, but returned to the former level in about one week after discontinuing the drug. A total of 119 Gm. was given. (Fig. 5.)

Abscesses usually respond to treatment in from five to eight days, depending upon the stage they have achieved before institution of treatment and upon the presence of cellulitis. If staphylococcic cellulitis is treated before there is any tendency to localization, resolution may take place

without pus formation. If pus does form, the abscess will be insignificant. When an abscess has already begun to form, the

methylthiazole therapy was commenced on the sixteenth day and kept up for eight days, gradually tapering off at the end. A blood level

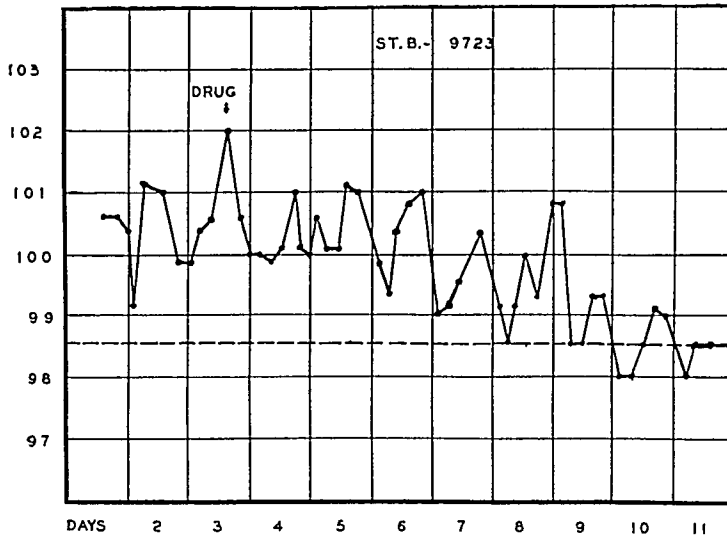


FIG. 5. Temperature chart, Case 3. St. Barnabas, No. 9723.

time taken to clear up the cellulitis and the abscess together is usually several days longer. One case with cellulitis and abscesses took twelve days, while Case iv, with multiple intractable abscesses throughout both breasts cleared up within five days. Another patient failed to be affected by sulfamethylthiazole. She had honeycombed abscesses throughout the scalp and subaponeurotic region following an injury to the scalp and extensive cellulitis. She also had diabetes.

CASE IV. E. O. G. H., No. 38840. A white female, 38 years of age, weighing 120 pounds, was delivered of a child five weeks previously and subsequently discharged in good condition. Several weeks later she was admitted for incision and drainage of an abscess of the right breast and allowed to go home the following day. Four days later, during an attack of grippe, her left breast became painful and swollen. Fluctuation developed and she was again admitted for incision and drainage. The left breast was swollen, red, and painful to touch. Abscesses were honeycombed throughout the left breast and considerable fluctuation could be detected. Cultures from the abscesses revealed hemolytic staphylococcus aureus. They persisted for two weeks and were not improved by the usual hot, wet dressings, etc. Sulfamethylthiazole therapy was commenced on the

sixteenth day and kept up for eight days, gradually tapering off at the end. A blood level of free drug of 3.1 mg. per cent was attained and she received 23 Gm. altogether. On the fourth day she complained of nausea which subsided after several subsequent doses and did not return. The case is of particular interest because of the great rapidity with which the previously intractable abscesses disappeared. There was no recurrence after her last discharge from the hospital. Urine and blood counts were entirely normal except for a leukocytosis at first, due to the infection.

#### COMMENT

It must be understood that chemotherapy alone is not sufficient treatment for abscesses or any other collection of pus that is accessible. Incision and drainage are fully as important. Drugs and proper surgery should supplement each other and the former should also be employed to prevent spread of infection. If there is an abscess containing purulent material under tension, the patient's temperature will remain elevated despite continued thiazole therapy and will subside promptly following incision and drainage. The contents may be found to be sterile.

Furuncles should not be subjected to surgical interference. Such treatment is made all the more unnecessary by the

thiazoles. Hot, wet dressings of magnesium sulfate or boric acid should be employed as usual. In other words, these various lesions should be handled in the customary manner with the addition of thiazole medication by a suitable route.

While it is difficult to estimate accurately the value of drugs in terms of clinical improvement, certain reasonable criteria can be set up. If a furuncle, carbuncle or abscess treated with a drug disappears in less time than the shortest time required for an untreated lesion of the same kind, and if a sufficiently large number of these do the same thing, we are justified in accrediting the result to the particular type of therapy used, being careful to see that other medications and treatment do not influence the result.

The series herein presented fulfills these criteria, and, therefore, we claim that the thiazoles are of definite value in the treatment of staphylococcic lesions such as furuncles, carbuncles and abscesses.

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## TWO POINT COAGULATION

### A NEW PRINCIPLE AND INSTRUMENT FOR APPLYING COAGULATION CURRENT IN NEUROSURGERY

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THE usual bipolar current to produce hemostasis in neurosurgery has done much to make present day neurosurgery possible. This method employs a common electrode applied to the patient's body which covers so large a surface that no local effect is produced at this electrode. At the active electrode the point which applies the current is so small that only a minute area of tissue is affected and this area is subject to considerable coagulation.

With a current strong enough to produce coagulation there is some damage to surrounding tissues since the current must spread by eventually passing to the common or body electrode. The farther from the active electrode, the greater the mass of tissue bearing the current and therefore the less damage to any molecular part. (Fig. 1.)

A current strong enough to produce the needed coagulation of bleeding vessels in scalp, dura or brain produces some damage to the surrounding tissue, with slight carbonization, necrosis and later tissue reaction. This is particularly undesirable in the brain itself, where the current may be carried along a vessel, resulting in tissue changes at a considerable distance from the point of coagulation. There is also a rather objectionable contraction of the vessel being coagulated which may shrink it beyond the field of vision even before complete hemostasis is secured. This shrinking is extremely noticeable in dural vessels. If coagulation is not carefully done, with minute amounts of current, later closure is difficult, and postoperative tissue reaction must ensue. These factors have limited the scope of electrocoagulation

and have caused some authors, notably Bailey, to be exceedingly critical of its use.

In attempting to remedy some of the evils we have constantly kept a nurse at the electrocoagulation unit so that the coagulating current might be varied continuously to use only the smallest possible amount. The smaller the active electrode the smaller the amount of current necessary. The usual ball type electrode was therefore replaced by fine tipped forceps with a wire attached to the handle. (Fig. 2.) If a vessel had to be coagulated with a large current (occipital sinus for example) a hemostat placed between the coagulating forceps (or hemostat and grounded to the patient) could be used effectively to bypass the current so that the effect did not pass beyond this electrical short circuit into the vessel and deeper tissue. (Fig. 3.) This prevented shrinking of the vessel and obviously minimized tissue changes.

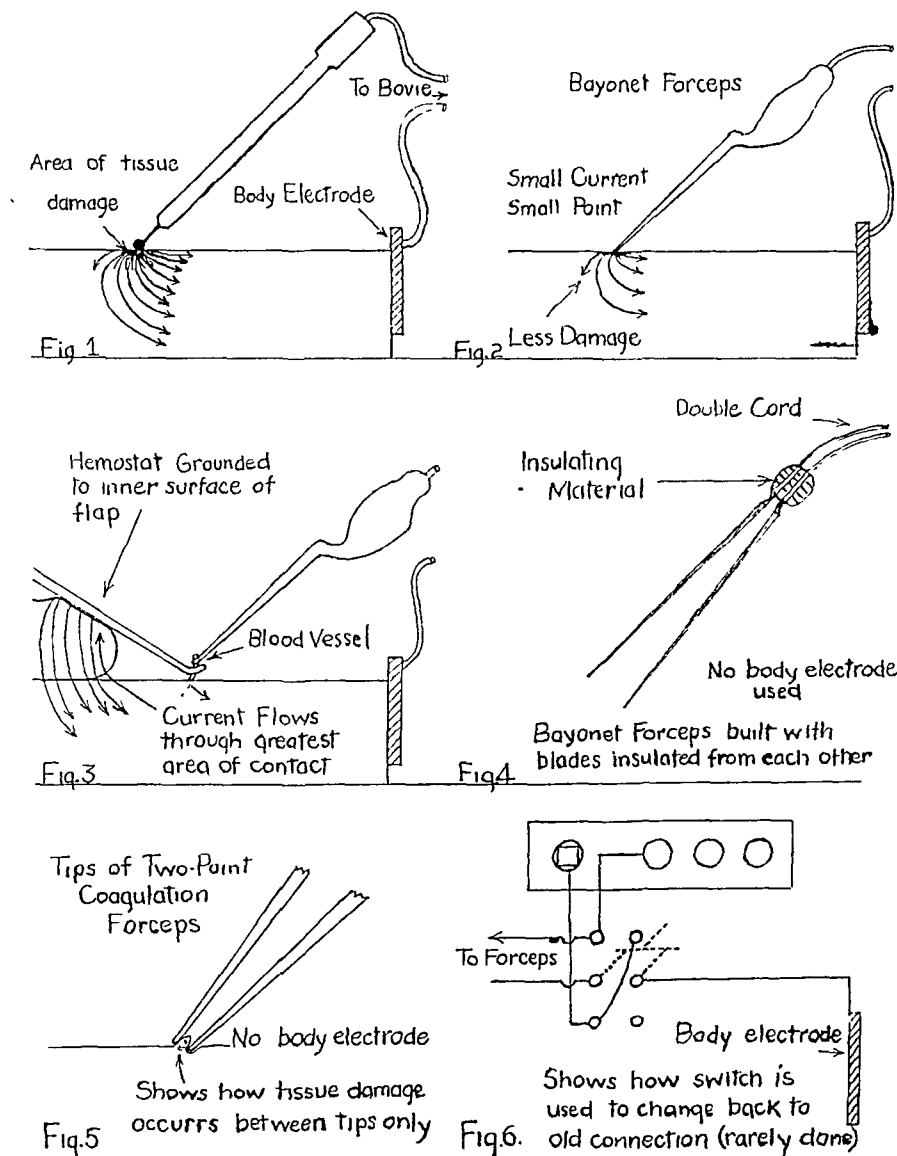
Although there was much improvement we still had a little carbonization at the point of contact unless we were very careful and there was also still some spread of the current a millimeter or so from the point of contact.

A method suggested itself which may find considerable use not only in neurosurgery but in general surgery as well. The body electrode was thrown away and a forceps was constructed (Fig. 4) with the two blades insulated from each other so that the current could pass from one tip to the other, coagulating only the tissues in between. One electrode is connected on the electrocoagulation machine where the patient electrode is usually connected; the

other to the active electrode terminal. While there is a slight spread of current as shown by the diagram (Fig. 5) this

as with the one point current even when the greatest precautions are taken.

This method of coagulation has another



FIGS. 1 to 6.

becomes minimal when the blades are closed upon a blood vessel.

To use this instrument, vessels must be picked up accurately so that the vessel actually lies between the tips. If the bleeding point cannot be picked up in this manner the tips may be slightly separated ( $\frac{1}{16}$  inch) and the coagulation which occurs between will cause hemostasis. Slight carbonization results, not so great

advantage which we had not foreseen. It may be used where some blood or saline solution surrounds the point of coagulation. This does not seem greatly to hinder its effectiveness, further proof that coagulation occurs only between the forceps blades since salt solution does not produce an appreciable short circuit. As is well known, a fairly dry field (saline sucked away) must be produced with the usual one

point current before coagulation can be very effective.

Another interesting finding was that approximately one-fourth of the usual current was required for most work.

This instrument cannot supplant the usual methods of coagulation since it is rather ineffective, for example, in spraying the inside of a tumor capsule or in spraying a surface which has multiple bleeding points, etc. Here the usual current is superior. Obviously too, the usual body electrode must be used with cutting current. We have used a double pole double throw switch to change from one connection to the other. (Fig. 6.)

The instrument is valuable in cortical dissection and in the dura. In the cortex the vessels may be carefully held between the tips and a small current applied. This causes the faintest white area of dehydration, blood being seen in the vessel to either side. There is no shrinking and no carbonization. The incision may then be made with sharp scalpel through the avascular point. When vessels are met deeper in the cortex they may be coagulated and cut or may be coagulated after cutting by picking up the tips. Here again there is no shrinkage. In the dura there is no noticeable shrinkage and no carbonization. There is also no noticeable effect on the underlying cortex when the dura over it is coagulated.

We have used the two point forceps to stimulate the cortex in attempting to reproduce focal convulsive seizures and in determining cortical localization. They are obviously well adapted to this. The current is, of course, alternating (2 to 5 volts) and the instrument must be temporarily disconnected from the electrocoagulation unit to permit its use in this procedure.

We have used two point coagulation in twenty major neurosurgical procedures and while we do not expect it to revolutionize present methods it is probable that some will find it a useful addition to the present armamentarium.

We were exceedingly grateful to Mr. A. K. Gillis of Pendleton and Arto, Inc. for making

us an instrument which is mechanically and electrically excellent and one which is easy and comfortable to handle.

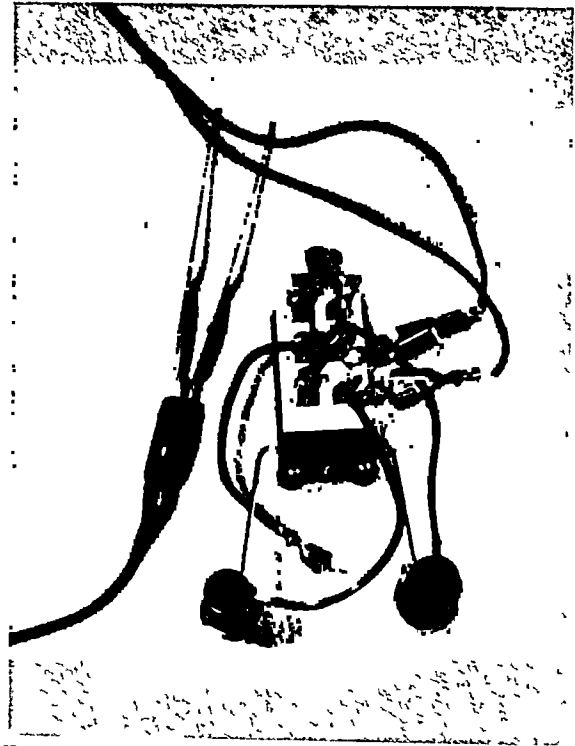


FIG. 7. Two point coagulation forceps with switch which allows transfer from the two point to old one point coagulation.

### CONCLUSIONS

A new and simple principle of electrocoagulation is presented, for use in securing hemostasis in neurosurgical work. An instrument is described which has been used in applying this method.

The essential features of the principle are that the usual body electrode is dispensed with and a forceps is so constructed and used that the current appears only between its tips. Obviously, the closer the tips are placed the smaller the field of electrical activity will be and consequently the smaller the area of tissue coagulated.

The following advantages are claimed:

1. The amount of electrocoagulation current necessary to secure hemostasis is less than one-fourth that required by the usual method.
2. There is less carbonization, tissue dehydration and ensuing tissue reaction.



3. There is no shrinking of the blood vessels being coagulated and current is not carried along a blood vessel into deeper tissues.

4. There is no appreciable shrinking of the dura when a vessel is coagulated on its surface or edge nor is there any noticeable effect on the underlying brain.

5. Coagulation is possible under saline and while washing with saline.

6. Cortical incisions may be made through avascular coagulated points on cortical blood vessels, minimal damage being produced in coagulation since current

flows only between the forceps tips. Coagulation occurs only in the vessel held and not in the brain tissue which is adjacent.

A switching arrangement is presented whereby the old method of coagulation may be resumed instantly should the need arise. It is noted that this method should supplement, not supplant the old connection.

We believe this instrument and its connection for "two-point coagulation" should find use in neurologic surgery and possibly in general surgery as well.



AN artery is sometimes *pushed forwards* by an underlying growth, and its pulsation in a more than usually superficial position may suggest an aneurism.

# A METHOD FOR REMOVAL OF AREAS OF BRAIN FOLLOWING FREEZING IN SITU\*

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THE purpose of this report is to describe a method for removal of areas of brain following freezing in situ. Cats were used as the experimental animals. The brain was exposed under pentothal anesthesia. In the first group of

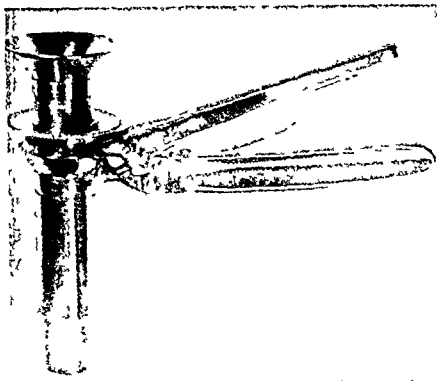


FIG. 1. Illustrates the complete instrument for application to the cortex.

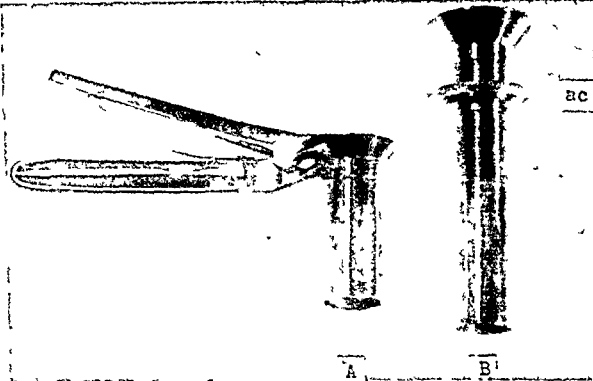


FIG. 2. Illustrates the component parts of the instrument. It consists of two metal cylinders, "A" and "B"; the inner cylinder, "B," is 10 cm. long with a funnel top convenient for pouring, and an adjustable collar (ac). The outer cylinder, "A," 5 cm. long is equipped with a handle and spring lever.

a living animal. The technique consists of delivering the area of brain after freezing with liquid nitrogen. By this method of refrigeration, areas of brain are removed with minimal distortion of tissue and with minimal bleeding. Its feasibility for cortical and subcortical biopsy is apparent, and its use in brain tumor surgery may prove valuable.

## METHOD

The principle of the method is to apply a freezing agent to the area of brain to be removed, sufficient to freeze it solidly. This permits delivery of the frozen mass in toto without significant hemorrhage. Several available freezing agents were tested; liquid nitrogen was chosen because of its refrigeration properties and its safety. Preliminary observation found the liquid to be sterile.

experiments it was found that pouring liquid nitrogen over an exposed area of brain in the presence of a certain amount of bleeding was ineffective in producing satisfactory freezing, because the liquid nitrogen rolled off the brain without sufficient time elapsing for freezing. An instrument was therefore devised through which the nitrogen is poured and bubbles for a moment over the area outlined for freezing. The tissue is hardened within a few seconds by the rapidly evaporating liquid, and the frozen segment is then removed.

Figures 1 and 2 illustrate the instrument: It consists of two metal cylinders, "A" and "B"; the inner cylinder, "B," is 10 cm. long with a funnel top convenient for pouring, and an adjustable collar (ac). The outer cylinder, "A," 5 cm. long, is equipped with a handle and spring lever. The depth of the segment to be

\* From the Neurosurgical Service, Montefiore Hospital, Pittsburgh. Prepared with the aid of a grant from the Isaac Kaufmann Foundation.

removed is determined by the adjustable collar of the inner cylinder. This cylinder is then placed in the outer cylinder and the

cylinder is then delivered by pressing the lever arm. The outer cylinder which is adherent to the frozen surface is readily



FIG. 3. Illustrates the instrument in situ in a cat after the freezing agent has been applied.

instrument is ready for application to the surface of the brain. After the cortex is exposed the instrument is inserted to the depth of the previously determined projection of the inner cylinder beyond the outer.

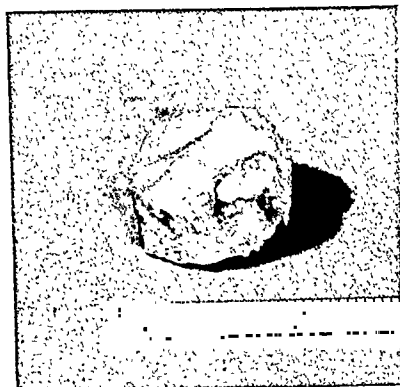


FIG. 4. Illustrates a removed frozen cortical segment.

The liquid nitrogen is then poured into the funnel top causing freezing of the chosen segment within a few seconds. Hemorrhage resulting from the insertion of the instrument is promptly controlled by refrigeration. The instrument in situ is illustrated in a cat. (Fig. 3.) After refrigeration for about one minute the inner cylinder is slowly elevated by turning the adjustable screw which exerts considerable mechanical advantage. The core of frozen tissue captured in the inner

lifted from the cortex. The frozen segment removed is illustrated in Figure 4. The slight hemorrhage which usually follows the removal of the instrument is easily controlled by pouring a small amount of liquid nitrogen into the bleeding area. This congeals the blood and a dry crater remains. With the segment removed and hemostasis complete the operative site is ready for closure. Muscle flaps are placed over the crater area and skin sutures complete the closure. The animals exhibited less shock following the removal of the brain tissue by this method than one would expect following the previously used surgical procedures. This problem is under further investigation.

Two of the animals were sacrificed after a month's observation. The crater and surrounding tissue were examined grossly and microscopically. The site of the crater revealed a small amount of old hemorrhage with apparent organization. Microscopic study of the area adjacent to the crater at a distance of about 5 mm. showed small hemorrhages but preservation of the cellular structure. Further pathologic study is in progress concerning the direct effect of freezing on the cortical cells as well as its physiologic effect in such animals. Microscopic examination of the biopsy removed

at operation revealed preservation of cortical architecture.

*Comment.* These animal experiments indicate that refrigeration may be a useful procedure in neurologic surgery. Cortical and subcortical hemastasis can be obtained in a cat by this method. At the depths tested, vessels can be prevented from bleeding before they can be exposed. In its present form the method may be useful for obtaining cortical and subcortical biopsies. Its practical value as an aid in the removal of brain tumors is being tested. It may be possible to simplify the removal of vascular tumors by previously freezing the neoplasm in situ in accordance with the technic described. While this method is by no means intended to supplant accepted procedures such as electrocoagulation, it may prove to be a useful adjunct to brain surgery.

#### SUMMARY

A method for removal of areas of brain following freezing in a living animal is described. An instrument has been devised for the removal of brain tissue frozen by liquid nitrogen. The use of the procedure in the cat has been demonstrated. The value of the method as an adjunct to neurologic surgery, especially in the removal of vascular tumors, is being tested.

The authors wish to express their thanks to Dr. K. Y. Yardumian of the Montefiore Hospital for his help in the pathological studies; to Ernest Sauerland and Sons of Pittsburgh, for their cooperation in making the instrument; to the U. S. Bureau of Mines, Pittsburgh, for their valuable suggestions and to the Air Reduction Sales Company of Pittsburgh for generously making liquid nitrogen available to us.



# FAILURES IN RHINOPLASTIC SURGERY

## CAUSES AND PREVENTION

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THE school of rhinoplastic surgery founded by Professor Jacques Joseph disappeared in great measure with the

other facial disfigurements became increasingly great.

Plastic surgery, and rhinoplasty in par-

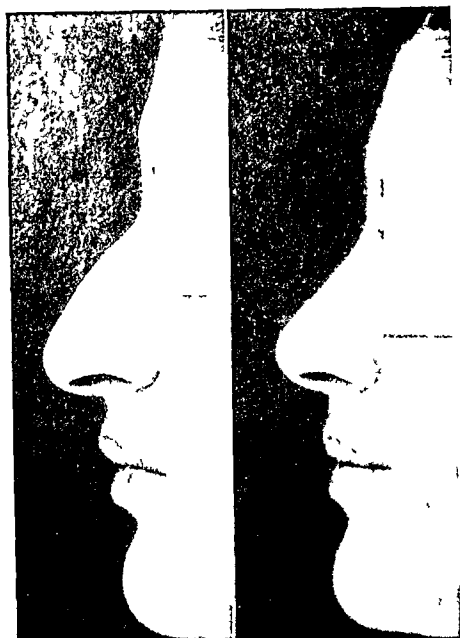


FIG. 1.  
FIG. 1. Convex profile.  
FIG. 2. Following correction.

advent of the Third Reich, when he became an exile and died shortly thereafter. Teaching facilities in this branch of surgery became restricted because only a few men were able to associate themselves with the small group of Joseph's pupils in this country.

Lectures, scientific publications and demonstrations of patients during a decade or more have convinced the medical profession that a profound psychologic factor is involved when a nasal disfigurement is either properly or improperly corrected. When rhinoplastic procedures gained the approval of the medical profession, the demand for the correction of nasal and



FIG. 3.  
FIG. 3. Prominent profile.  
FIG. 4. Following reduction.

ticular, present a dual problem. First, the technique must be mastered as in all surgical procedures; second, equally or even more important, is the art of creating "form" which has a definite esthetic value. Success in rhinoplastic surgery, therefore, depends upon a combination of surgical training and an innate creative ability. Because the essential artistic instinct is a personal faculty, it accounts for the varied attainments of even well trained men.

The admittedly large proportion of unfavorable results following rhinoplastic operations is a definite indication that the

majority were done by men lacking in one or the other of the essential qualities. Some results show ample evidence that both prerequisites were lacking. The patients often suffer secondary surgical disfigurements, varying in degree from an unnatural appearance to actual mutilations. It is difficult to exaggerate the great injury inflicted and the social and economic loss.

The patient who submits himself to a rhinoplastic operation does so with the expectation that the disfigurement which is a hindrance to economic or social progress will be eliminated and a normal nose, conforming to general esthetic conceptions, will result.

The esthetically normal nose is in proper proportion to the other facial features in length, breadth, and profile elevation. An important element of a satisfactorily reconstructed nose is that it must not show evidence of having been operated upon. One must particularly avoid what is commonly known as a "surgical nose."

The first group of cases illustrated here shows the various types of nasal disfigurements before and after correction. Particular attention is called to the normal appearance of the corrected noses and especially to the fact that the nasal tip retains the normal esthetic curves provided by nature. (Figs. 1 to 8.)

An analysis of rhinoplastic failures shows that they usually fall into one or more of three groups. The secondary surgical disfigurement involves either the upper, middle or lower third of the nose. The individual steps of a complete rhinoplastic operation can be considered and the more common errors which lead to unsatisfactory, and sometimes truly amazing results, can be pointed out. This study is based on my experience with a large number of patients who sought physical and emotional relief from an unsatisfactory rhinoplastic operation or from a secondary surgical deformity.

#### 1. *The Upper or Bony Third of the Nose.*

In this category the surgeon is usually concerned with the removal of a nasal hump,

or the lowering of the profile line and the narrowing of the nasal bridge.

The errors commonly committed which



FIG. 5.

FIG. 5. Long humped nose

FIG. 6.

FIG. 6. Normal proportion following correction.

lead to poor results are as follows: (a) the removal of bony structure without a compensative reconstruction of the rest of the nose, resulting in a bird-beak effect (Fig. 9); (b) cutting through the right and left side of the nasal hump at unequal levels, producing a flattening of one side or the other; (c) failure to cut the dorsal edge of the septum down to the same level as the lateral walls, producing a "razor edge" nasal dorsum instead of one with a normal width; (d) failure to narrow the nasal bridge, resulting in a flat dorsal plateau with retraction of the skin into the hiatus created by the removal of the hump (Fig. 10); (e) failure to produce a complete fracture of the lateral walls, tending to widen the nasal bridge; (f) deviation of the bony septum, preventing a proper "in-fracture" of the affected side, resulting in a scoliosis; (a deviation of the bony septum must al-

ways be corrected prior to any attempted narrowing of the nasal bridge) (Fig. 11); (g) cutting through the frontal processes of the



FIG. 7. Long nose with wide hanging tip.



FIG. 8. Normal appearance of tip following correction.

superior maxillae at an improper level, producing a step-like thickening at the base of the nose.



FIG. 9. Bird beak effect due to incomplete operation.

The surgeon who undertakes to perform rhinoplastic operations must realize from the foregoing axiomatic statements that an exacting technique is of prime importance and that any slight deviation therefrom or error of judgment regarding measurements, proportions, or position, will produce a disappointing result.

2. *The Middle Third of the Nose.* This consists of the lateral cartilages and the septum.

A nasal hump, or an excessive profile elevation, is rarely confined to the bony structure alone. The cartilages of the middle

third of the nose are usually an integral part of the nasal hump and these structures must therefore be brought down to the newly created level of the bony part.

Errors are: (a) failure to level the septum to the required profile line, leaving a cartilaginous hump or a dorsal convexity (Figs. 12 and 13); (b) the lateral cartilages must be trimmed down to the newly leveled septum, because failure to carry out this step leaves an elevation on one or the other side of the midsection of the nose; (c) the lower portion of the lateral cartilages must be trimmed in order to reestablish a normal relationship between the lateral and alar cartilages. If this trimming is not carried out an excessive thickening of the nasal tip results, with an obliteration of the nasal vestibule. (Fig. 14.) It is important to bear these points in mind in order to avoid an unsightly secondary disfigurement after an otherwise properly performed nasal correction.

The necessity for a secondary correction following a primary rhinoplasty is not always an indication that the original correction was improperly performed, provided no surgical disfigurement results.

The conservative surgeon makes a sufficient allowance for the normal dropping of the nasal tip after the primary shortening. But the exact degree of dropping cannot always be anticipated, because the muscular action and tonus of the labial muscles vary in different individuals. (Fig. 15.)

A secondary shortening of the nose is indicated in about 10 per cent of patients.

Other secondary corrections which may aid in the final satisfactory result are, either an additional narrowing of the nasal tip or of the nostrils.

esthetic. The cartilages may be too large or disproportionate. Faulty technique or disregard of the anatomic functions of the cartilages will always result in a distinct



FIG. 10. Failure to narrow nasal bridge.



FIG. 11. Failure to correct septal deformity prior to plastic correction.

3. *The Lower Third of the Nose.* It will be obvious from the foregoing that great caution is necessary in corrections involving the lower third of the nose. It is in this

surgical disfigurement. We see more patients with surgical disfigurements or mutilations of the nasal tip, than with any other type of secondary rhinoplastic deformity.



FIG. 12.

FIG. 12. Failure to level cartilaginous hump to level of bony correction and insufficient shortening of nose.

FIG. 13.

FIG. 13. Same patient following secondary operation.

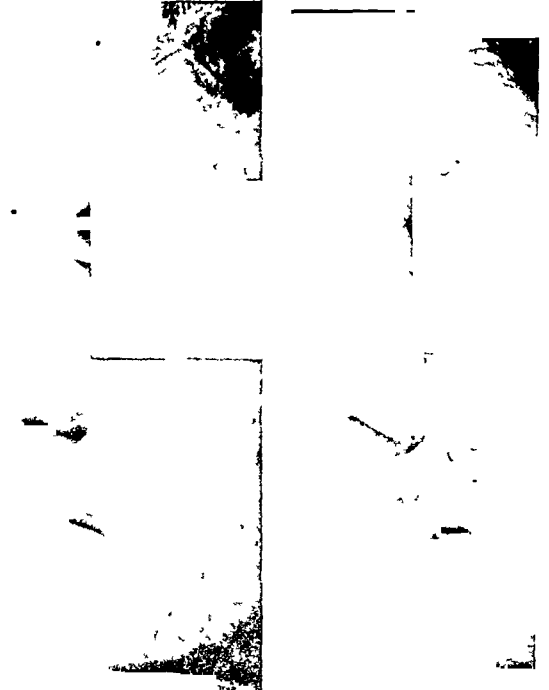


FIG. 14. Lower end of lateral cartilages curled up and producing a thick nasal tip.

FIG. 15. Excessive shortening of the nose.

area that the largest number of surgical disfigurements occur. The cartilages comprising the lower third of the nose have, aside from other functions, one definitely

The end result in the correction of these mutilations depends upon the degree of destruction of vital nasal tissues. When the disfigurement is slight a considerable



measure of improvement can be brought about, while the more flagrantly distorted noses are almost beyond repair.



FIG. 16 Pinched tip and failure to shorten hanging columella.

I have described<sup>1</sup> the most satisfactory techniques employed in corrections involving the lower third of the nose to avoid the most common errors.

(a) In shortening the nose, the watchword should be *conservatism*. The nose should be shortened to an extent somewhat



FIG. 18 Retracted columella.

less than the length of the chin line. The usual amount of postoperative droop is about 2 mm. When it exceeds this, it is preferable to carry out a secondary shortening, following which there is usually no postoperative dropping of the nasal tip.

(b) The narrowing of the nasal tip should be carried out with the objective in

mind that sufficient alar cartilage and mucosa must remain to afford proper support for the overlying skin. The commonly



FIG. 17. Shrinkage of tip due to complete removal of alar cartilages.

observed pinched-tip effect will thus be avoided. The alar cartilages should never be removed completely. (Figs. 16 and 17.)

(c) A rather common surgical disfigurement is a retracted columella. This effect is produced by the removal of the posterior surface of the columella while shortening



FIG. 19 Mutilation due to improperly performed Weir operation.

the nose. (Fig. 18.) Such a deformity is not easily remedied because a supporting structure has been lost. It seems to me that the error is made with the assumption that a "hanging septum" can be corrected by removing the posterior half, or more, of the columella. As a matter of fact the "hanging septum" is merely an excessive convexity of the anterior edges of the columellar cartilages. When this condition is present it calls for specific correction, the technique for which is described in my book,<sup>1</sup> as well as in Professor Joseph's "Die Rhinoplastie."<sup>2</sup>

One step in a general rhinoplastic correction which requires careful consideration is the reduction of the size of the nostrils

by the excision of a triangular section, anteriorly or posteriorly. During the operation one may get the impression that the

previous operation, was unnecessarily narrowed, resulting in a typical adenoidal facies. Unless one is certain that this step



FIG. 20. Mutilation of nasal tip due to improper surgical technique.



FIG. 21. Same patient following a series of corrective operations.



FIG. 22.

FIG. 22. Profile view of same patient in Figures 20 and 21.



FIG. 23.

FIG. 23. Profile view following correction.



FIG. 24. Mutilation of nasal tip due to improper surgical technique. Front view.



FIG. 25. Same patient following a series of corrective operations.

nostrils appear larger than before. This is frequently due to the novocaine infiltration, and subsides after the solution is completely absorbed. I have observed many instances where the base of the nose, in a

is indicated it is best to defer it until all swelling has subsided. It will then rarely be found necessary to reduce the size of the nostrils. As a rule, the narrowing of the nasal tip, according to the technique

described in my book, will diminish the size of the nostrils sufficiently to make the second operation unnecessary.



FIG. 26. Same patient, as in Figure 24, profile view prior to secondary correction.



FIG. 27. Same patient profile view following secondary correction.

Another alar operation which is far too frequently performed is what is com-



FIG. 28. Failure to approximate the columellar cartilages.



FIG. 29. Following corrective operation.

monly called the Weir operation. It consists in the excision of a crescentic section of the alae at their attachments. This is indicated only in persons with true negroid nostrils. In all other instances which I have

observed, this operation flattens the nostrils and obliterates the nasolabial fold. It constitutes a surgical deformity which, as far as I am aware, has not been successfully corrected by a secondary operation. (Fig. 19.)

#### CONCLUSIONS

I ardently advocate conservative surgery even if the necessity for a slight secondary operation should arise and if the esthetic requirements of the patient demand it. It is obvious, however, that the primary operation must produce a decided improvement in the patient's facial appearance.

When the primary operation is unskillfully performed and a definite surgical disfigurement is produced, it may require a series of secondary operations, each more difficult and complicated than the original one before the patient can be restored to economic usefulness, or saved from a state of physical depression and a life of social ostracism. Unfortunately, some of these patients are so severely mutilated that they cannot return to their gainful occupations, especially if a "presentable appearance" is requisite. Figures 20 to 29 are examples of severe surgical mutilations of the nasal tip and the results obtained after a series of corrective plastic operations.

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# THE SURGEON AND COLONIC ALLERGY\*

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EVERY surgeon of long experience can recall patients who seemed to require immediate operative interference because of typical symptoms of an acute abdomen and who, when the abdomen was opened, showed only an edema of the intestinal walls which seemed to subside during his manipulations, or an erythema for which no definite surgical treatment seemed to be indicated. Also, unfortunately, many patients have been explored to determine the reason for indefinite but troublesome symptoms, nothing very definite was found and the abdomen closed, or a routine appendectomy performed. Many of these mistakes are made because in the preoperative study the possibility that the symptoms might be caused by an allergic reaction has been overlooked. It is important for the surgeon as well as the internist to become "allergy-conscious" so that embarrassing or even dangerous situations of the type just described may be avoided. Laymen have long recognized the fact that certain otherwise nourishing foods would invariably produce bowel symptoms and have avoided them, or, as is so frequently the case in sensitization to milk, have used the particular food for cathartic purposes. In recent years much has been written about allergy, a special nomenclature for describing its phenomena has been developed, and much experimental work has been carefully carried out, and yet it is a fact that many perfectly obvious cases are constantly being overlooked by the general practitioner and the specialist.

The cause of allergy has not been determined. Its hereditary transmission along Mendelian lines has been amply proved. We know that in some way the endocrine glands play a part in the tendency to

allergy, experiments with extracts of adrenals, the pituitary and the parathyroids having demonstrated that these glands and perhaps others influence allergic manifestations. Autonomic imbalance has been described as an etiologic factor. We have seen, in some cases, a complete disappearance of allergic symptoms after patients have had a thorough eradication of all focal infections, have moved from one climate to another or have suffered from a febrile disease. The seasonal occurrence of symptoms, not only because of exposure to or ingestion of substances peculiar to certain seasons, but often apparently because of a change in body metabolism, has been observed, and in some cases deficiency states, especially subvitaminosis, have seemed to play an important part in the condition. Trauma has also been considered an important factor in initiating sensitivity. Just as the etiology of allergy is apparently so varied, even the nature of the actual substances producing the symptoms is still a subject for disagreement. It is now generally considered that a specific protein is the cause, although some have in the past insisted that split proteins produced the phenomena. Recently histamine has been implicated. Drugs and chemicals have been known to produce manifestations exactly like those caused by protein sensitivity and even "physical allergy," with reactions to light, heat, cold and electricity has been demonstrated. The problem of bacterial allergy is being studied and seems to involve some changes in our conception of infection and immunity. The fact that areas of skin or mucous membrane may be sensitized to specific proteins by intracutaneous or intramucosal injections of serum of persons

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sensitized to those proteins is also an interesting observation.

The reactions caused by allergy in the colon are directly observed by the surgeon at proctoscopy or operation and indirectly by the roentgenologist in the course of a gastrointestinal study. In 1925,<sup>1</sup> I suggested that the reactions could be shown to parallel the then better known changes in the respiratory tract, with mucosal and neuromuscular manifestations. The mucosal reactions then described were hyperemia, hypersecretion, edema, often followed by local ischemia, necrosis, sloughing and ulceration, hemorrhage or perforation, and if chronic or repeated, by induration, fibrosis and adhesions. Submucosal hemorrhages, producing the petechial or purpuric areas often seen on proctoscopy, may break down and bleed. The neuromuscular reactions were described as consisting of motility disturbances, spasms and dilatations. In recent years Walzer, Gray and Harten and their co-workers<sup>2,3</sup> have demonstrated allergic reactions experimentally in the human rectum, and in the ileum and colon at the site of colostomies. In Rhesus monkeys they have produced reactions in the intestines, have removed specimens during the reactions and have demonstrated the microscopic findings. They passively sensitized areas of mucosa of rectum, ileum or colon simultaneously with an area of skin on the arm, by injecting into these sites small amounts of serum from a person sensitive to peanut protein. Then on feeding a peanut mixture by mouth, instilling it into the bowel or applying it locally, they observed the reactions. In the skin these consisted of the usual urticarial wheals. In the mucosa they usually consisted of excessive secretion and pallor, followed rapidly by a steadily increasing edema and marked hyperemia, the reaction still being present after two hours and then gradually subsiding. These local reactions began to appear in from five to eight minutes after the administration of the antigen, proving its rapid absorption in

the unchanged state, even when given by mouth. Obviously it was not advisable to repeat the experiments at sufficiently close intervals to produce more severe or chronic changes, but these can be readily imagined. Microscopic changes observed in specimens of stomach and bowel of monkeys removed during an allergic reaction consisted of edema, more marked in the deeper layers, especially the muscularis mucosae, and of round-cell infiltration (usually eosinophiles) and beginning interstitial changes. In 1937 Kaijser<sup>5</sup> resected a piece of human small intestine during an acute allergic reaction and demonstrated marked edema and eosinophilic infiltration. Appendices removed in acute appendicitis are often found to be infiltrated with eosinophiles.

*Mechanism.* Experimental work confirms what clinical observation has long led us to believe, that the reactions in the gastrointestinal tract are caused less frequently by direct contact of the food with the mucosa than by the irritation from absorbed unchanged protein reaching the organs through the blood stream. While absorption of unchanged protein from the upper part of the gastrointestinal tract has been shown to be very rapid and to occur independently of the amount and character of the gastric secretion, it has long been felt that gastric anacidity may enhance the speed of such absorption. The addition of solvents to the food, notably alcohol, may also cause more rapid absorption and in some patients has been known to be necessary to the production of a reaction.

*Symptoms.* Allergic reactions in the colon such as have just been described would, according to their severity, produce a variety of symptoms. The milder early reactions, with erythema and hypersecretion as a prominent factor and motility disturbance or spasm as a complication, would produce the symptom complex usually described as "mucous colitis" or the equally indefinite syndrome now called "irritable colon." A more severe reaction could be called colon spasm or colitis, or

with more marked edema and thickening could produce a picture of acute intestinal obstruction or an acute inflammation or perforation. The most severe mucosal reactions, starting with edema and erythema followed by marked hyperemia and infiltration, by herpetiform rashes in the mucosa, and subsequent sloughing and denudation of the mucosa, present the picture of so-called "idiopathic" ulcerative colitis. In the anal region, any of these changes, even those showing only mild hypersecretion and edema, are usually associated with more or less marked pruritus, and in my opinion most cases of this distressing condition can be traced to an allergic cause. Some of the very marked anal and rectal conditions in which infiltration, ulceration and bleeding are found, have been shown to be allergic in origin. Intermittent gross hemorrhages, due to purpuric areas in the rectum or sigmoid, may frequently be traced to a food sensitization, and in these cases the presence of skin purpura during the attacks may be a clue to their origin.

**Diagnosis.** The diagnosis of allergy as a cause of colonic manifestations requires a careful study. It is only after a careful and complete gastrointestinal check-up has ruled out actual organic lesions or bacterial or parasitic invasions that we should be prepared to consider allergy as the sole or primary cause of the symptoms. Whereas in the past many patients have been incorrectly treated or uselessly operated upon because allergy was not recognized, there is grave danger today that the clinician who jumps at a diagnosis of allergy may be mistreating a patient with a definite infection such as a specific colitis or may be dangerously postponing operation for a malignancy. Even though the diagnosis of allergy may be correct, a more serious lesion may be masked by the more spectacular allergic symptoms, so that the importance of a complete gastrointestinal survey, with detailed history, gastric analyses, stool examinations and gastrointestinal and colonic Roentgen studies cannot be

overemphasized. The principal points in making the diagnosis follow:

1. The *history* constitutes the most important single diagnostic aid. Allergy may be suspected when any of the following facts in regard to the patient have been ascertained:

- (a) A family history of allergy, not necessarily of the same type as that found in the patient, but a story of asthma, hay fever, migraine, eczema, urticaria or any other periodically recurring illnesses in ancestors, brothers and sisters or even children. Allergy does not commonly produce the same manifestations in the different members of a family, although the Mendelian law seems to be followed so far as occurrence of allergy in general is concerned.

- (b) A previous history of definite allergic symptoms in the patient's earlier life. The previous occurrence of "bilious attacks" (migraine) and periodic diarrheas, respiratory or skin manifestations, either previously unexplainable or definitely attributed to certain foods or inhalants may be taken as evidence of an allergic tendency.

- (c) The onset or cessation of symptoms at puberty or the menopause, during pregnancy or after some great emotional stress is also very suggestive.

- (d) The observation by the patient that the ingestion of certain foods is always followed by certain definite symptoms. Among the more common gastrointestinal symptoms thus described are the diarrheas following the drinking of milk ("milk acts as a cathartic"), heartburn or "repeating" after certain foods and the abdominal cramps usually occurring after eating certain mixtures like fruit salads, salad dressings or soups, one or more ingredients of which may be the causative factor.

- (e) The occurrence of symptoms on a certain day of the week in persons living in institutions or in persons whose eating habits are so systematic that certain foods are always taken on certain days of the week. "Blue Monday" is often caused by

the fact that only on Sunday does the family eat chicken, and on Monday the members of the family who are sensitive to chicken suffer from migraine or diarrhea.

2. *Physical examination* may be of little or no assistance in making the diagnosis. Where other than colonic manifestations are present, the nasal mucosa may show the changes found in hay fever or vasomotor rhinitis, the eye may show hyperemia and even corneal herpes, the chest may be emphysematous from asthmatic attacks, the skin may show one or more of the many lesions known to be allergic in origin. Abdominal examination may disclose nothing of importance, may indicate some spasm of the colon or in the severe cases may show all the signs of an acute abdomen, simulating either an acute inflammatory or perforative lesion or an intestinal obstruction. In some cases the very rapid and complete disappearance of the symptoms and signs in these acute cases after the administration of a dose of adrenalin or ephedrine intramuscularly or sublingually often will give dramatic evidence of the allergic nature of the attack.

3. *Laboratory examinations* are of indirect value. Gastric anacidity may or may not be found. Excessive secretion of gastric mucus may be an indication of continued gastric irritation. Pylorospasm may cause temporary delay in gastric emptying. Stools may show excessive mucus in the milder cases, blood, mucus and even pus in the severe cases. Eosinophiles in the rectal discharges and marked eosinophilia shown in the blood count are very suggestive findings, especially when evidence of protozoal infestation can definitely be ruled out.

4. *Roentgen examination* may be of considerable value in the diagnosis of colonic allergy. In the gastrointestinal series, if the barium meal contains some substance like chocolate or acacia, to which the patient's gastrointestinal mucosa is sensitive, there will be noted mucosal puckering or rugal coarsening in stomach and duodenum, and spasms and mass contrac-

tions, rapid "writhing" peristalsis or actual reverse peristalsis in the duodenum. With the hypermotility the meal may reach the colon more rapidly than normally and evidences of colonic hypertonicity and hypermotility may be observed. In the opaque enema study, spasms and hypertonicity may be noticed and at times, where the enema contains offending substances, the mucosal changes may be seen by fluoroscopy or films. The well-known findings in ulcerative colitis, consisting of "fuzzy" outline, hypertonicity, obliteration of haustra and later deformities and defects, are quite marked and may be shown gradually to disappear as the condition improves.

5. *The determination of the allergic factor causing the reactions* is the most important part of the diagnosis. While at times history of occurrence of symptoms at the menstrual epoch will indicate a sensitivity to some hormonal factor produced at that period, their occurrence coincident with activity at some infective focus may suggest bacterial allergy or their occurrence after medication may indicate chemical or drug idiosyncrasy, most cases of colonic allergy are probably due to sensitivity to specific food proteins. At times the recognition of the cause of the symptoms is comparatively easy, as in the case where the patient has previously known of the cathartic effect of milk and has continued to take daily small quantities, sufficient, however, to produce continuous bowel irritation. One self-evident principle in regard to the determination of the food is that where the symptoms are continuous and chronic, the food must be one taken daily or very frequently, whereas intermittent attacks must be due to foods taken on more rare occasions. Attacks lasting a single day must be due to a single ingestion of the food, attacks of two or three days' duration to the eating of left-over or made-over dishes containing the food for a couple of days. Skin sensitization tests are of some value in determining the foods responsible for the reaction,

but it has been shown that foods giving skin reactions by the scratch, intradermic or patch methods, may not necessarily be concerned with any other than skin manifestations, and not always with these. In the determination of food allergies they have been practically abandoned. In the end the only real test is the keeping of careful records of repeated trials of a suspected food in order to be convinced of its effect. Various "elimination" and "addition" diets to aid in the determination of the offending foods have been suggested, the former consisting of fairly full diets in which daily changes or eliminations are made until symptoms clear up, the latter starting with nothing but water, or possibly the old Duncan Bulkeley rice and water diet, producing a cessation or marked alleviation of symptoms, and adding foods one or two at a time until reactions occur. The latter is obviously not suitable in cases where the patient is much in need of immediate nourishment. In any test diet it is necessary to get a complete cessation or marked alleviation of the symptoms in order that the detailed record of the diet taken during and preceding the period of relief may be compared with the foods taken during exacerbations. In general it may be said that a food to which a person is sensitive will always produce symptoms, even when taken in small quantities, so that if no symptoms occur after even a single ingestion of a food, that particular food may be absolved of blame for previous or subsequent symptoms. A possible exception to this rule might occur where sensitization to two or more single foods might be slight and the reaction hardly noticeable, but when these foods were taken at the same time a more severe reaction might occur.

In an effort to simplify the dietetic study, we have been using, in the past couple of years, two test diets, which have been of considerable help. Test Diet Number 1, containing foods usually taken daily by the average individual, is of value as a starting diet in cases in which

symptoms do not occur daily or continuously, and consists of only five foods: milk, egg, wheat, potato and orange (or where orange is known to be an offending factor, some other fruit may be substituted for it). These foods can be used to make a fairly satisfactory though monotonous diet as follows:

#### TEST DIET NO. 1

*5 Foods:* Milk, Egg, Wheat, Potato, Orange

*Breakfast:* Milk, egg, wheat cereal and cream, wheat bread and butter, and orange.

*Lunch:* Milk, egg or cheese, potato, bread and butter, dessert (orange-flavored custard or wheat pudding or whole orange).

*Supper:* Same as lunch or breakfast.

*Between meals and at bedtime:* milk with cream and glucose and wheat crackers.

On such a diet, three possible things may occur: (1) the patient may show no improvement, indicating either that the offending food is contained in the diet or that diet has nothing to do with the symptoms; (2) the patient's symptoms may be much exaggerated, indicating that one or more of the ingredients of the test diet are causing the symptoms; (3) there may be an alleviation of the symptoms and signs, or sometimes, in milder cases their dramatic cessation, indicating that the diet contains none of the foods causing the symptoms. If the third result is obtained, after a few days of this diet new foods are added one or two at a time, a record kept of the results and suspicious foods rechecked. If symptoms are the same or increased, one of two procedures is indicated, namely, the elimination of one of the five foods at a time until improvement is noted, later rechecking the foods suspected, or, perhaps what is even more advisable, the substitution of a test diet containing five foods, none of which have been present in the first diet. This diet we call *Test Diet Number 2*, and it consists of rice, rye, gelatin, one vegetable and one fruit. A sample diet of this kind would be as follows:

#### TEST DIET NO. 2

*5 Foods:* Rice, Rye, Gelatin, 1 Vegetable, 1 Fruit

*Breakfast:* boiled rice, rye crisp, gelatin drink, raspberries.



*Lunch:* Peas, rice, rye krisp, gelatin drink, raspberries.

*Supper:* Same as lunch or breakfast.

*Between meals and at bedtime:* Gelatin drink and rye krisp.

*Note:* The gelatin drink is made by adding a heaping teaspoonful of pure powdered gelatin to a fruit juice made of the fruit or berry used in the diet, sweetened and fortified with glucose. Butter does not contain sufficient milk protein to cause any reaction as a rule and is a valuable addition to this restricted diet. The procedure to be followed is the same as that described for the first test diet, and as a rule the offending food or foods can rapidly be ascertained.

*Treatment.* Aside from appropriate endocrine therapy, the eradication of all infective foci, local treatments which may seem indicated, or the use of sedatives and psychological treatments in patients who require it, the essential factor in the care of an allergic patient is to eliminate all offending foods from the diet. If the foods to be eliminated are those not ordinarily necessary to the enjoyment of a natural, well-balanced diet, this elimination is easily accomplished, and the patient can continue for the rest of his life, if necessary, without taking any of these foods. If, however, they are articles which occur in the normal daily diet, such as milk, egg and wheat, it is much more difficult to avoid foods containing them, and desensitization to these foods may be attempted. To do this it is not necessary to start with hypodermatic injections of the pure protein extracts of the food. Oral desensitization is entirely satisfactory. It is best to start with minute quantities each day, increasing the quantities gradually until symptoms reappear and finally arriving at a dosage beyond which the patient cannot go without getting symptoms, but usually large enough to permit of the taking of food mixtures containing small amounts of the food, as in the case of milk in cereal or coffee, egg in pudding or ice cream, or wheat in crackers or cake. In the case of milk, the initial dose in begin-

ning desensitization should be one drop of whole milk, in the case of egg, one drop of a solution of a beaten egg in 8 ounces or more of water, in the case of wheat, a small pellet made of bread. In this connection it is well to remember that when desensitization has been attained, the patient must take the acquired dosage of the food every day, as omission of the food for even a few days will reestablish the sensitivity. This fact makes it undesirable to desensitize any patient to a food which he would not care to eat each day or could not obtain at different seasons. Nonspecific desensitization by the use of peptone intravenously or by the employment of various forms of artificial pyrexia has been fairly successful in some cases, but in recent years has been rarely employed. The injection of increasing doses of histamine has also at times accomplished a nonspecific desensitization.

In the *treatment of an exacerbation of acute symptoms*, such as an attack resembling an acute abdomen, or an acute intestinal obstruction, or in a very severe case of ulcerative colitis, it may be necessary to institute measures not ordinarily required in the more chronic case.

1. Frequently a hypodermatic injection of 1 c.c. or less of adrenalin chloride solution, 1:1000, will give immediate and almost miraculous relief of symptoms, although at times it may cause such distressing symptoms of thyroid stimulation as to make its use undesirable. At times pituitrin will give the same relief, but it may unduly stimulate peristalsis and thus, if a real acute abdomen were present, would do harm. Parathyroid hormone with calcium may also be of value. Histaminase has recently been used with dramatic effect in some cases, but is not constantly reliable.

2. Removal of the offending factors as rapidly as possible would seem to be most desirable. In milder cases, a dose of castor oil or even a lavage or a cleansing enema may be used as a first step. However, as absorption of the allergen is probably the

most important cause of the reactions, it is usually noted that reactions cease when further absorption does not occur because all present in the meal has been absorbed and because unabsorbed portions have become dehydrated in the lower bowel and therefore are no longer capable of absorption. I have seen patients develop secondary reactions when a saline cathartic was taken after subsidence of an attack, probably because of the liquefaction and absorption of protein which had been previously dry and unabsorbable. This is probably why castor oil, with its detoxifying as well as cathartic effect, is most desirable in these cases.

3. In order to keep up nutrition, restore normal gastrointestinal function, and avoid general dehydration, it is important to feed the patient early and frequently. A well-balanced diet should be administered as soon as the offending foods are known, careful choice of substitutes for these foods being imperative. Attention to adequate vitamin and mineral content is necessary.

*Prognosis.* The prognosis in any case of allergy is not good for cure. We know that sensitivity to a given food may never disappear or may suddenly cease spontaneously, only to be followed by sensitivity to another, previously innocuous food. We know that during and after pregnancy or following fevers there may be temporary and even at times, prolonged relief from symptoms, and on the other hand that puberty, pregnancy or the menopause may be periods when allergic manifestations may first and only be observed. It is also well to bear in mind that chronic irritation, due to the constant eating of foods to which a patient is sensitized may possibly be a factor in the etiology of cancer, and further study along this line may indicate the importance of the recognition and

treatment of allergy in the prevention of cancer. Already it is realized that the polyposis and fibrosis following ulcerative colitis form a soil in which carcinoma may develop.

#### SUMMARY

1. It is important that surgeons as well as general practitioners recognize the common allergic reactions in the colon.

2. Mild allergic reactions cause mucous colitis, mild spasms and "irritable colon," more severe mucosal reactions are the cause of ulcerative colitis.

3. Very severe edema and spasm may produce symptoms of acute intestinal obstruction or an acute inflammation, hemorrhage or perforation.

4. Allergy should not be made the primary diagnosis in any case until all organic causes for the symptoms have been ruled out by complete gastrointestinal and general study.

5. The primary treatment of allergy consists essentially of the elimination of the offending factors and of general hygienic care.

6. Desensitization, specific or nonspecific, and the treatment of endocrine, neurologic and metabolic disturbances, and removal of focal infections are necessary.

7. Allergy as a precursor of cancer deserves further study.

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# SUCTION OPERATION FOR TOTAL REMOVAL OF CATARACT

REPORT OF 228 CONSECUTIVE CASES

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THE writings of preceding and contemporary ophthalmic surgeons provide us with an immense reservoir of descriptive material and statistical fact which make a comparative study of the various surgical methods of cataract removal a task of huge proportions. Even the study of the development of a single technique is a work of no inconsiderable magnitude. And yet it is extremely important that the surgeon be kept fully and reliably informed regarding the different techniques available in order that he may evaluate in his own mind, and adapt to his own particular skill and ability, that method which will be most successful in his own hands. It seems inconsistent with good reason to insist, as many do, that the inexperienced surgeon, or one who operates only occasionally, should learn to use an old and perhaps inefficient technique simply because it has the approval of others.

There can be no doubt today of the superiority of intracapsular over extracapsular methods. Clear media with no need for repeated needling operations; lower incidence of postoperative inflammatory reactions; and avoidance of the depressing period of waiting for cataracts to ripen are all well recognized advantages of intracapsular methods.

That many general ideas regarding the Barraquer suction cataract operation<sup>1</sup> have never been adequately understood and that others pertain to an earlier and now outmoded stage in the evolution of the technique is not universally recognized. It is the earnest desire of the writer to call attention to a need for revision of these concepts. Unfortunately simple facts are often the

most difficult to explain because they are frequently obscured by criticism based upon a lack of understanding and by the devious purposes of commercial interests desiring to introduce new instruments and equipment. It should also be recognized that even after a surgical technique has reached a stage of practical perfection it continues to undergo many minor personal modifications so that aside from its basic features the operation eventually becomes quite individualized among the surgeons who use it. Perhaps no two surgeons employing the suction technique do so in exactly the same way. It should be understood that this discussion pertains primarily to the technique as described below.

The vacuum or suction method for cataract extraction is not among the older and more traditional procedures. However, it has been widely enough used by outstanding European and American surgeons so that reliable statistics on large series of cases can be compared with those from the older methods of intracapsular and extracapsular extraction. The suction operation now stands as the first important and successful surgical cataract technique utilizing modern electrically driven precision instruments and embodying an original and radical departure from all of the older ideas and previous concepts regarding the surgical removal of cataracts.

Barraquer was first to describe the removal in toto of cataracts by the use of an electrically driven vacuum pump. The suction idea first occurred to him while watching a leech, which was stuck to the side of an aquarium, lift a small pebble with its caudal end. Barraquer devised the original

vacuum equipment and instruments which made possible the practical application of the method. With a thorough realization of the remarkable possibilities of his empirical efforts, he attempted at once to explain all the workings of the technique by his own concepts of its mechanics, but many of his theories are not now universally accepted. This is especially true of his idea of the importance of a pulsating or interrupted vacuum. The mechanics of this Barraquer attempted to explain by analogy to a weight jerked from the end of a piece of string. Few today would consider any value in the use of a pulsating or intermittent vacuum. A continuous and smoothly applied vacuum is considered preferable. Castroviejo<sup>2</sup> is emphatic in his opinion that a pulsating vacuum is quite unnecessary.

The vacuum may be controlled either by the tongue, by a foot valve or by the finger controlling an opening in the suction end piece. For over two years I employed the lingual vacuum control as devised by Nugent<sup>3</sup> but later returned to the use of the foot valve which I consider more convenient and sanitary; and which permits better control of the amount of vacuum desired. The optimum amount of vacuum varies according to the case. It must be applied gradually in order to allow the capsule and lens substance to mould into the cup. The manner of application and degree of vacuum are governed by individual judgment. In most cases a vacuum equivalent to 50 to 55 cm. of mercury is sufficient to rupture the zonule, but occasionally from 1 to 10 cm. more are required. Valves permit the application of the precise amount required. The valve is also a safety mechanism, for it permits the operator to release the vacuum instantly. Mechanical suction syringes do not allow for this variable control of the degree of vacuum nor for its immediate discontinuence.

Anesthesia, mydriasis, akinesis, lid control, retrobulbar injection and precaution against infection are accomplished in accordance with individual preference. They have been widely and extensively discussed

in the literature and there is no need for lengthy discussion here.

For surface anesthesia the writer prefers a  $\frac{1}{2}$  of 1 per cent pontocaine solution because of its stability and because it does not have the dehydrating effect upon the corneal epithelium that a comparably effective solution of cocaine has.

For mydriasis Barraquer's solution containing 2 per cent euphthalmine is alternated with instillations of 1:1000 adrenalin. Several instillations produce rapid and adequate mydriasis of short duration. If constriction of the pupil is desired at the termination of the operative procedure, these mydriatics will not prevent the effective use of eserine as does mydriasis with atropine.

Before beginning the operation the lower lacrimal punctum is dilated and 1 to 2 c.c. of 1:3000 bichloride of mercury in petrolatum (White's ointment) is injected directly into the lacrymal sac. This has a twofold purpose: (1) it destroys any infectious organisms that may be lurking in the lacrimal passages; (2) it prevents the gastric upsets which frequently result from the toxic effects of excessive and rapid absorption by the nasal and pharyngeal mucosa of many of the solutions which drain through the lacrimal passages from the conjunctival sac.

Akinesis may be obtained either by the method of O'Brien<sup>4</sup> or by that of Van Lint.<sup>5</sup> Lid anesthesia is not important but it adds to the patient's comfort and may be easily attained by injecting a few c.c. of a solution of 2 per cent procaine with adrenalin into the subcutaneous tissues of the lids. Retrobulbar injection of 1.5 c.c. of the same solution produces a deep anesthesia of the entire globe and temporarily reduces the intraocular tension.

Lid control is most efficiently obtained by the method of Horner<sup>6</sup> which eliminates the work of an assistant. The sutures are placed in the lid at the beginning of the operation. A speculum is used only until the corneal section and iris incision have been made and the conjunctival sutures are

placed. The speculum is then removed before delivering the lens and thenceforth the lids are controlled by the sutures weighted

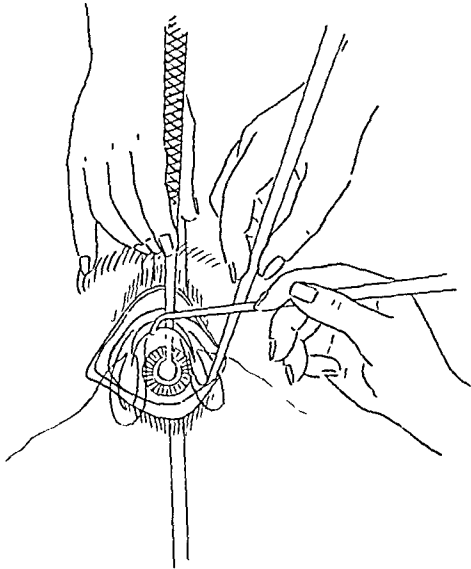


FIG. 1. Direct application of suction cup to anterior capsule. Corneal section held open with forceps by assistant. Slight counter-pressure with ball-tip forceps below.

with small hemostats. In this way, assistants' hands need not occupy any important part of the operative field and there is no need for a superior rectus suture.

An external canthotomy is performed when necessary.

The corneal section comprises slightly less than one-half the circumference of the cornea and includes a narrow conjunctival flap. A continuous or running conjunctival suture with attached atraumatic needles is placed in the conjunctival flap before the lens is delivered. The loops are drawn back into the canthi so that they do not interfere with the lens as it emerges from the wound. The ends of this suture extend beyond the eye so that by pulling them taut the wound may be closed immediately after delivery of the cataract. In this way, if any vitreous tends to prolapse, its loss may be kept to a minimum.

The ideal surgical and cosmetic result is attained with a round, active pupil and with the cataractous lens entirely removed. Incarceration of the iris in the wound is a

complication to be avoided, especially when a total iridectomy has not been made. Both of these facts, as well as the probable behavior of the patient postoperatively should be borne in mind at the time the decision regarding the type of iris incision is made. In general, I prefer a peripheral iridotomy by Elschnig's<sup>7</sup> method, making a small slit near the iris root with a DeWecker scissors alone and avoiding the injury to the iris common when forceps are used. Where the iris has good tone and the slit-lamp reveals no slits or other signs of atrophy, where there is no posterior synechia, and where the iris is not injured in making the corneal incision, a peripheral iridotomy is the ideal way in which to deal with the iris. In aged or one-eyed patients, in patients who cannot be kept quiet because of some bodily infirmity, or where posterior synechia or other evidence of former uveal inflammation is present, where the pupil cannot be dilated, or in the presence of extensive uveal atrophy or chronic glaucoma, a narrow total iridectomy is preferred. Posterior synechia does not preclude the possibility of intracapsular cataract extraction as is sometimes stated. In this series of 228 cases, total iridectomies were performed in 148 cases. In the remaining eighty cases the iris was dealt with in such a manner as to leave the pupil round and intact at the completion of the operation. A preliminary iridectomy was done only for some one-eyed patients or in the presence of an associated glaucoma or a high persistent arterial hypertension.

To Barraquer the most important function of the suction end piece or erisiphake was to rupture the zonule. He even referred to this instrument as a pneumatic forceps and zonulotome. At first Barraquer advocated turning or tumbling the lens into the anterior chamber by rotating the erisiphake about the axis of its handle. Later he extracted the cataract without tumbling it and felt he had made distinct progress. Van Lint,<sup>8</sup> Fisher,<sup>9</sup> Green,<sup>10</sup> Wright,<sup>11</sup> Saint-Martin,<sup>12</sup> LaGrange<sup>13</sup> and others have described their methods of using suction in

which the tumbling maneuver is given considerable prominence. LaGrange, however, has recently emphasized the importance of

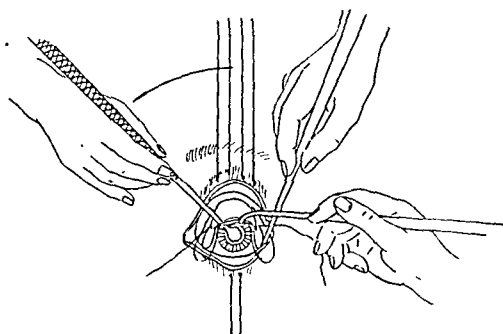


FIG. 2. Note change in axis of suction end piece as the entire lens is rotated around the axis, passing through anterior and posterior poles of crystalline lens.

first rupturing the zonule by rotating the lens in the plane of its equator before tumbling it. The version or tumbling maneuver is primarily intended to complete the rupture of the zonule. If this can be accomplished by rotating the lens by a tortional movement, the need for tumbling is abolished and the cataract can be delivered directly by traction and slight counter-pressure without ever turning the end of the suction end piece out of view. In this way the forensic objection to the suction technique—that there exists an imminent danger of aspirating the vitreous should the lens become detached from the vacuum cup—is entirely obviated.

The author's method of direct extraction, without tumbling, by rupturing the zonule by rotating the lens in the plane of its equator, and by keeping the open end of the suction end piece constantly in view is illustrated in Figures 1 to 4. It is particularly emphasized that the incidence of vitreous loss is reduced to a minimum, seldom attained with any other technique.

In this series of 228 cases, in previous studies<sup>14</sup> and in an extensive experience with hundreds of other suction operations I have never observed the loss of a single drop of vitreous by aspiration into the suction end piece. When vitreous loss occurs with this technique it is due to excessive counter-pressure, to movement by the pa-

tient, to contraction of the orbicularis muscles, or other undue pressure on the globe by instruments or by the lids. The vitreous

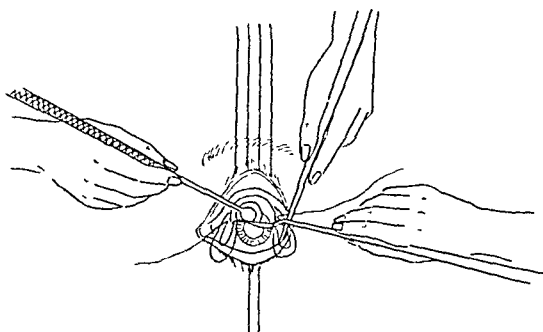


FIG. 3. With the zonule ruptured, the cataract is delivered by traction and slight counter-pressure.

escapes into the conjunctival sac just as in any forceps operation and does not disappear into the suction apparatus.

Considering the anatomy of the eye and the physical problem involved in the direct extraction of cataract by the utilization of a pneumatic forceps, it is not surprising that vitreous loss is neither an imminent danger nor an important complication. The crystalline lens is suspended by the zonular fibers which extend from the anterior and posterior capsule of the lens in the region of the equator to the ciliary valleys and processes of the ciliary body. These zonular fibers form an open network through which aqueous filters and also affords a direct open pathway between the retrolental space and the posterior chamber. The posterior chamber and the anterior chamber are directly continuous through the pupil. In other words, after the corneal section has been done and the eyeball opened, atmospheric pressure is transmitted directly through the pupil and the interspaces between the zonular fibers to the anterior condensation layer of the vitreous. Therefore when the vacuum cup is placed on the anterior capsule of the lens with the wound held open, the vacuum is not transmitted to the vitreous. Atmospheric pressure is not removed from the anterior vitreous surface nor from the posterior surface of the lens.

Failure to comprehend these simple facts has led writers to describe the "pushing

out"<sup>15</sup> of the lens by the vitreous as a vacuum cup is applied to a part of the anterior lens surface. This is an entirely

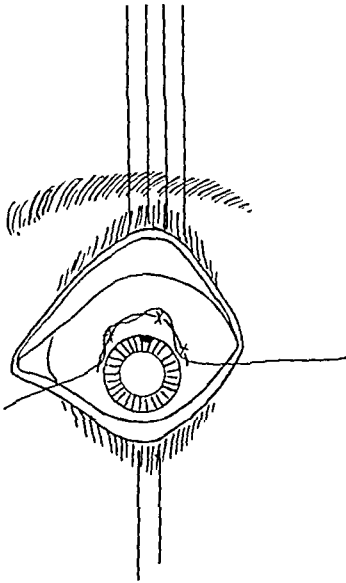


FIG. 4. The continuous conjunctival suture is pulled taut, closing the wound immediately after delivery of the cataract.

false concept of the mechanism of the suction technique. (See Figs. 1-4.) When the proper degree of vacuum has been applied, the lens can be lifted from the anterior vitreous surface exactly as with any other type of forceps but with much less danger of rupturing the capsule. In a recent paper<sup>16</sup> Barraquer complains that much of the criticism directed toward the suction operation has been based on incorrectly executed operations, diversified techniques, and a complete misunderstanding of the essential factors. He points out that one should be especially careful not to attribute to a technique disadvantages which should be charged to the surgeon.

A peripheral iridectomy or an iridectomy makes an even more direct pathway for the application of atmospheric pressure onto the anterior vitreous surface.

Clinical records of 228 consecutive cases recently operated on by the author by the technique described afford an interesting statistical study. The patients ranged in age from 19 to 94 years. In over 80 per cent of the cases the cataracts were in incipient

stages. Inability or failure to deliver the cataract in toto occurred in ten cases, and cataracts were totally removed in slightly more than 95 per cent. These percentages are in close agreement with those recently reported by Arruga.<sup>17</sup> Vitreous loss occurred in only thirteen cases, or slightly less than 6 per cent. The amount varied from a few beads to a moderately large amount, but in no case did loss of vitreous prevent healing or recovery. Postoperative wound infection occurred in one case in the entire series.

It should be generally understood that 100 per cent corrected visual acuity is obtainable in every case operated by an intracapsular technique without complications, providing that the parts of the visual apparatus other than the lens are normal. However, since in many cases ocular structures other than the crystalline lens have undergone pathologic changes, normal visual acuity is not to be expected always. Statistics regarding visual results are therefore of little value unless accompanied by extensive and modifying pathologic descriptions. All that is necessary is that each patient be given an accurate appraisal of the condition of his eyes before operation and an estimate of how much visual improvement may be expected.

#### SUMMARY AND CONCLUSIONS

In total extraction of cataract the suction operation is highly successful, permitting intracapsular extraction in over 95 per cent of the cases in which it is attempted. Vitreous loss is not a common or serious complication.

On the combined basis of complete removal of the cataract, minimal complications, and best possible visual results, the conclusion is reached that the suction operation stands out among the best surgical techniques for removal of cataracts.

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# POSTOPERATIVE PULMONARY COMPLICATIONS

## AN ANALYSIS OF ETIOLOGY, DIAGNOSIS, PROPHYLAXIS AND TREATMENT

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THE subject of pulmonary complications following surgical procedures has long been a source of worry to both surgeons and internists. The incidence is reported as high as 5 per cent in all operations, and 10 per cent in those limited to the abdomen. A University of Pennsylvania study<sup>1</sup> shows a morbidity of 1.68 per cent and a mortality of 0.54 per cent, with 8.35 per cent of the operative mortality entirely attributable to the pulmonary lesion.

### ETIOLOGY

No single factor is believed responsible, but certain factors related to the incidence and etiology should be stressed.

1. *Site of Operation.* The highest incidence is found after abdominal surgery, especially in the upper abdomen. King<sup>2</sup> found an incidence of 14 per cent among 3,000 abdominal cases (hernioplasty included), and only 1 per cent among 4,000 operations elsewhere on the body, thyroidectomy comprising the major portion of this latter group. It is an axiom that *the more closely the operative procedure approaches the diaphragm, the greater is the incidence of postoperative pulmonary complication.* This is explained by resultant immobilization of the abdominal muscles together with elevation of the diaphragm, often as much as 6 to 8 cm., with a corresponding reduction in vital capacity. A 50 per cent reduction in vital capacity after lower abdominal operations and 85 per cent reduction after gall-bladder operations were noted by Churchill and McNeil.<sup>3</sup> These changes reach their height twenty-four hours after operation, and return gradually to the preoperative level

over a period of one to three weeks. Davis<sup>4</sup> observed that the preoperative chest roentgenogram in the expiratory position is almost identical with the postoperative roentgenogram in the inspiratory position.

2. *Sepsis in Operative Field.* Upper abdominal sepsis undoubtedly adds to the restriction of diaphragmatic contraction. Ryan<sup>5</sup> stresses the importance of infection in the operative field in the production of postoperative pulmonary complications. The manner of spread may be by direct extension, via lymphatic channels, or by embolic means.

3. *Preëxisting Respiratory Infection.* Acute infections are quickly recognized and unequivocally forbid all but emergency operations. Subacute and chronic infections are too often glossed over in the preoperative physical examination; they demand equal consideration. Acute respiratory infections are often acquired during the preoperative period of study, possibly due to unaccustomed changes in dress, bed coverings, and ventilation, or to transportation to and from surgery along drafty corridors.

4. *Anesthesia.* Endless controversies have arisen as to the part inhalation anesthesia plays as a causative factor. Irritative inhalation anesthetics, with resultant increase in bronchial secretions and formation of mechanical plugs, are potent factors. But, according to Brock,<sup>6</sup> "It is not sufficiently appreciated that the incidence of a chest complication depends on a combination of several circumstances and but rarely on one factor alone. To imagine that the simple replacement of inhalation anesthesia by local or spinal anesthesia for a patient known to be a bad risk will avoid such a complication shows a childlike faith born of

inexperience or insufficient observation. While it is desirable to avoid an irritant inhalant, it is even more important to take certain other precautions, and, unless these be taken, it is absurd to be disappointed with the results of the use of local or spinal anesthesia." Brown and Debenham<sup>7</sup> report an incidence 4.29 times greater with spinal than with inhalation anesthesia.

5. *Bronchial Obstruction.* Several factors combine to promote thoracic immobility and shallow breathing, with the subsequent formation of bronchial mucus plugs. Tracheobronchial secretions, increased by inhalation anesthesia or preëxisting bronchial infection, accumulate dependently during a prolonged operation in the supine position. Muscle splinting following abdominal incisions and large dosages of opiates promote such an accumulation. In many cases this accumulation is disposed of during recovery as soon as the patient vomits or coughing is reëstablished. In others a mucus plug is formed. Constricting bandages, often made tighter by gaseous distention, hinder expulsion of such a plug. Retention is also facilitated by immobility, whether due to senility, obesity, primary causal illness, prolonged, exhaustive operation, lack of normal stamina, or to the condition of major invalidism often urged upon the patient by his relatives and friends.

Tracheobronchial secretions are raised largely by the "tussic squeeze" or "bechic blast." This cough is a protective mechanism, stimulated by the accumulation of secretions which it attempts to raise. Prescription of cough sedatives to relieve such a cough cannot be too strongly condemned.

It is doubtful whether atropine should be used, either pre- or postoperatively, as it undoubtedly hinders drainage by thickening secretions. It is better to aspirate secretions as they arise.

Band and Hall<sup>8</sup> have shown by experiments on dogs that the three factors that tend to cause massive atelectasis are the presence of a plug of tenacious mucus in a bronchus, the abolition of the cough reflex (as after morphia), and limitation of respira-

tory movements. Coryllos<sup>9</sup> analyzes various theories as to the etiology of pulmonary collapse, and concludes, "I consider bronchial obstruction as the only *determining* cause of atelectasis."

6. *Predisposing Factors.* The highest incidence is during middle life. It is twice as high in men, possibly due to their greater reliance on abdominal respiration, increased exposure to the elements, and more rigid costal cartilages. A higher percentage of upper abdominal surgical lesions, with concomitant postoperative splinting of the diaphragm, raises the incidence in males. The seasons of prevalent upper respiratory infections have also the highest incidence of pulmonary complications.

#### CLASSIFICATION

Postoperative pulmonary complications may be classified according to their time of onset.

1. *First to Fifth Day.* Atelectasis, of the obstructive type, due invariably to a plugged bronchus; rarely occurs after the fifth day.

2. *Fifth to Eighth Day.* Unclassified group, in which pneumonia apparently falls; preceded by atelectasis.

3. *Subsequent to Eighth Day.* Embolic complications and lung abscess, of which atelectasis is the precursor.

Such a scheme is not meant to include every case, but its adoption facilitates early and often life-saving therapy.

1. *Atelectasis.* This is a frequently met complication which arises within a few hours to five days after operation, usually occurring in a quiet patient suffering intensely from pain. Many varieties of atelectasis are recognized, varying from massive or lobar collapse, with clear-cut physical signs, to a patchy or lobular, scattered atelectasis with signs and symptoms often erroneously labeled as bronchitis or bronchopneumonia. However, lobular atelectasis is often the forerunner of these complications. The condition is frequently bilateral.

The onset is almost always abrupt, with

rapid and shallow respirations; occasionally there is pain and distress. The temperature is elevated, and the pulse rises to 120 to 160. As the symptoms progress, cyanosis rapidly intervenes, and dyspnea, fatigue, apprehension, sweating, postural inclination towards the affected side, and a sense of oppression or retrosternal discomfort are noted. A typical fruity cough, from "gargling" of retained, thick, mucopurulent material in the trachea and large bronchi, is quite characteristic.

Most of the complications occur on the same side as the operation. This is probably not because of the operative site, but occurs as a result of the lesser angle of the right stem bronchus with the trachea, so that the tracheal secretions gravitate into the right lung, analogous to foreign bodies.

The diagnostic physical signs are, displacement of the heart to the affected side, lagging or decreased expansion with an impaired to dull percussion note, and breath sounds which are strikingly variable, depending on expectoration of mucus plugs; loud bronchial breathing may appear in a previously silent area after expectoration of thick sputum.

Roentgenograms in the diagnosis of atelectasis are unquestionably of great value, but they are not always typical, and usually are interpreted as pneumonia. The elevation of the diaphragm and narrowing of the interspaces on the affected side, together with displaced organs, are the most striking diagnostic features of the roentgenogram. These findings are absent in partial atelectasis, and it is almost impossible to differentiate these cases from pneumonia by x-ray or physical examination. The author believes they should be diagnosed and treated as atelectasis if they occur within the first five days after operation.

The sputum is typically thick, viscid, mucopurulent, tenacious, and not blood-stained, in contrast to the rusty sputum of a true pneumonia or the blood-tinged sputum of a pulmonary infarct.

A postoperative pulmonary complication having its onset within five days of operation should be considered atelectasis until

otherwise excluded. Pneumonia is believed to be a further stage of the same atelectatic process. Lung abscess follows the pneumonitis which was superimposed upon the atelectasis. Pol Coryllos<sup>9</sup> considers atelectasis an initial, integral part of postoperative pneumonia; he believes the latter to be identical with pneumococcic atelectasis. Bronchial obstruction, according to the same author, is the starting point of postoperative bronchitis, lobar or lobular pneumonitis, and probably of abscess and gangrene. The particular condition arising depends upon the virulence of the infecting agent.

An early diagnosis is therefore essential so that treatment may not be delayed. The longer the interval between onset of symptoms and the beginning of treatment, the more danger is there of pulmonary abscess. The prognosis of properly treated cases is good, recovery occurring in some cases as a result of one treatment (therapeutic bronchoscopy).

2. *Pneumonia.* True lobar pneumonia is a rare sequel to operation. Postoperative bronchopneumonia is more frequent and is almost always a very serious condition, occurring as it does in a type of patient most unfitted to withstand a heavy infection. In the past it has been commonly diagnosed in error when only atelectasis was present; it actually represents an advanced stage of atelectasis. Prophylaxis, therefore, must be energetically directed towards the initial atelectatic process. Once postoperative bronchopneumonia has developed, the clinical picture resembles the medical entity.

3. *Lung Abscess.* Lung abscess is always a late complication, often delayed as long as two weeks after operation. The atelectatic processes progress into a pneumonitis and then form an abscess cavity. The diagnosis is based on a rapid progression of atelectatic symptoms, the onset of cough with sputum, gradually becoming more severe, and the sudden expectoration of large amounts of very foul sputum (due to the rupture of the abscess into a bronchus). The prognosis varies directly with the time

of institution of therapy and the time of onset of the disease.

4. *Embolism and Infarction.* This occurs in most cases after the eighth postoperative day, after physical exertion, in a patient without pain, as contrasted to the early onset of atelectasis in a quiet patient with pain. There is usually no collapse except with a massive embolus. Recognition is based on sudden pleuritic pain below the scapula, slight elevation of temperature, and tachypnea, with development two to three days later of friction rub in 50 per cent of cases,<sup>9</sup> dullness, and either a non-productive cough or blood-tinged, frothy sputum.

5. *Bronchitis.* Bronchitis occurs in about 3 per cent of cases, as a simple productive cough with fever and no abnormal signs in the chest beyond a few râles. Resolution follows in a short time with no evidence of severe or permanent damage. The danger lies in the application of this simple diagnosis to more serious conditions, which it may precede.

#### PROPHYLAXIS

Postoperative pulmonary complications may largely be prevented if certain measures suggested by their etiology are utilized in the care of the patient.

1. *Preoperative Care of the Respiratory Tract.* Only the most urgent operations should be done in the presence of an acute upper respiratory infection. Chronic disease, such as tonsillar and dental sepsis, should be eliminated before all elective surgery; pulmonary abscess is not infrequently the result of infected teeth. Impatience of patients and relatives should not prevent postponement of such cases. Patients should be seen on the morning of operation, and examined for recently acquired colds or changes in temperature.

2. *The Operation.* An incision as atraumatic as possible, causing the least after-pain, and the least splinting of the upper abdomen and diaphragm, will prevent in part postoperative hypoventilation and its sequelae. Careful handling of tissues will result in less shock, with its concomitant im-

mobility and lowering of resistance. Jones and McClure<sup>10</sup> advocate a transverse incision for upper abdominal operations, reporting only five cases of embolism with two deaths and no cases of atelectasis or pneumonia in 125 surgical cases in which this incision was employed.

Extremely tight upper abdominal dressings are to be avoided, and, unless there is a definite indication, upper abdominal binders are not to be used. Adhesive strips placed in "X" fashion in epigastric dressings should prevent constriction of the lower ribs.

3. *Anesthesia.* An irritant inhalation anesthetic is to be avoided whenever possible, and if one is given, the anesthesia should be smoothly and skillfully maintained. The reduction of the anesthetic period to the shortest possible time is of definite prophylactic value. Every patient who presents himself must be *individualized* and the anesthetic selected that is safest from every standpoint.

Pol Coryllos<sup>11</sup> has suggested the use of intratracheal insufflation anesthesia with bronchial suction, thereby preserving respiratory potency and pulmonary ventilation, and facilitating elimination of bronchial contents before, during, and after operation. Such anesthesia is becoming more popular as skill in administering it is more widely acquired.

4. *Morphia and Atropine.* Opiates should be used postoperatively to lessen sensibility to pain, but in doses small enough not to inhibit respiration or the cough reflex; this will allow bronchial drainage by cough without fear of wound pain. Pantopon may be substituted for morphia because it has a noticeably decreased tendency to thicken bronchial secretions and thereby causes less interference with their drainage. Belladonna or atropine given postoperatively first suppresses secretion, but then renders it more viscid and hinders expulsion.<sup>9</sup>

5. *Position and General Care.* The patient should be elevated to semi-Fowler position immediately after he reacts from the anesthetic; if he has received spinal

anesthesia, the foot of his bed should be elevated 6 inches for two hours, then placed flat for two hours, and then low Fowler's position. The benefits are derived from less hypostatic congestion and more complete lung expansion.

Coughing, to rid the tracheobronchial tree of sputum, should be encouraged by abdominal support and judicious use of narcotics. Supervised deep breathing exercises, performed with slow inspiration (less pain) and rapid expiration (to raise mucus to cough level), should be conducted at frequent intervals as soon as consciousness is regained. The patient should be turned from side to side after abdominal operation, at intervals of one-half to two hours (varying with quantity of bronchial secretion), when operative conditions safely permit it. Bronchial drainage should be insured for at least forty-eight hours postoperatively, when the lung defenses are impaired.

6. *Carbon Dioxide Inhalations.* Eliason and McLaughlin,<sup>1</sup> Lahey,<sup>12</sup> and MacKenzie<sup>7</sup> endorse the routine use of carbon dioxide inhalations, noting a decreased incidence of pulmonary complications in patients receiving the benefit of its use. However, King<sup>2</sup> and Ryan<sup>5</sup> report no appreciable differences in two large controlled series. The hyperventilation, maintenance of the inspiratory position, and violent tracheobronchial movements resulting from the use of carbon dioxide inhalations open atelectatic areas and aid the expulsion of obstructive secretions retained from hyperventilation. Carlson<sup>13</sup> believes this effect to be too temporary to be of value, as he found shallow abdominal respirations resumed within two to five minutes after discontinuance of the inhalations. Coryllos<sup>9</sup> claims that carbon dioxide inhalations decrease the hydrogen ion concentration of the exudate and thereby inhibit the growth of pneumococci, and also favor proteolysis of fibrin in the exudate, rendering it more expectoratable.

As there are no untoward effects except diuresis and increased acidity of the urine, the inhalations should be given after all

abdominal surgery, in a 10 to 25 per cent mixture with oxygen, for three minute periods at intervals of fifteen to thirty minutes; they should be begun immediately after operation and continued for four to six hours, or longer if deemed necessary. Hyperventilation at the conclusion of the operation should be a routine part of the anesthesia. However, "To expect to solve our problem by directing a nurse to hold a funnel over a patient's face at regular intervals is to put a very low value on the difficulties before us."<sup>6</sup>

7. *Drugs for Prevention of Embolism.* Various drugs have been advocated, principally by European investigators, for prophylactic use in reducing the incidence of postoperative embolism and infarction. The merits of these drugs—calcium gluconate, eupaverine, ephedrine, synephrin, and others—have not been substantiated, and they are seldom recommended. Peripheral thrombectomy has been successfully employed on some occasions as prophylaxis against embolism.

Patients with low basal metabolic rates may be given thyroid extract pre- and postoperatively, to raise metabolism and increase the rate of circulation.<sup>14</sup> Where the basal metabolic rate is low, the results have been favorable.

Eupaverine and papaverine are frequently used in treatment of cases of embolism which do not have a sudden termination.

Thus, no one factor is responsible for postoperative pulmonary complications, and, unless steps are taken to control every factor, no marked success is likely to be attained in their prevention.

#### TREATMENT

If proper pre- and postoperative care is used, atelectasis will seldom occur, and pneumonia and lung abscess will thereby be prevented.

1. *Atelectasis.* Once atelectasis is established, treatment should be directed to overcome bronchial occlusion and insure

free drainage of the bronchial tract. Adjustment of tight dressings, changes in posture, deep breathing, active efforts at coughing, and 10 to 25 per cent carbon dioxide inhalations are of inestimable value. Postural drainage, performed by having the patient breathe deeply and cough while lying in the lateral position with the involved side uppermost, will often expel much obstructive mucus. The patient should lie in bed on the non-involved side, to facilitate drainage and expansion of the atelectatic areas. If these routine procedures do not result in either preventing or relieving the atelectasis, further treatment is imperative. Bronchoscopy is indicated where the patient cannot expectorate or is growing worse.<sup>4,9</sup> The fact that a patient is practically moribund does not contraindicate a bronchoscopy. A carefully planned bronchoscopy can easily be done in any hospital, at which time the pulmonary secretions are aspirated, and inspissated plugs of mucus, if present, can be removed.

The routine administration of oxygen to a patient with a postoperative pulmonary complication, especially one with a plugged bronchus, cannot be too strongly condemned. Remember, the plug must be removed before oxygen can reach the alveoli.

2. *Pneumonia*. Postoperative pneumonia should never develop if proper and immediate treatment of the preceding atelectasis is instituted. Once it has developed, it demands the same treatment as any other pneumonia.

3. *Lung Abscess*. Lung abscess following an abdominal operation is primarily an atelectasis. Suppuration develops slowly, and may be prevented by bronchoscopic aspiration during the period of atelectasis. Of Davis'<sup>4</sup> fifteen cases of postoperative atelectasis which did not respond to the ordinary palliative procedures and had prompt bronchoscopic aspiration of the secretions, not one developed an abscess. Chevalier Jackson<sup>15</sup> has reported similar results. Early bronchoscopic aspiration with direct medication cleared up several of Negus'<sup>16</sup> cases of lung abscess.

Atelectasis is not the initial pathologic state in abscesses following operations about the upper air passages. In these cases, there is a fulminating onset and rapid abscess cavity formation as the initial lesion.

4. *Embolism and Infarction*. Embolectomy has been successfully performed in opportune cases, but a rapidly fatal course forestalls therapy in many instances. Eupaverine and papaverine are of distinct aid in favorable cases.

5. *Bronchitis*. The therapy of uncomplicated cases is purely medical, as for any other bronchitis. Bronchopneumonia must be guarded against, and appropriately treated when it arises.

The following two case histories are presented in illustration of the above principles.\*

CASE 1. D. McG., 21 year old white American youth, in previous good health, was admitted to Emergency Hospital, Washington, D. C., on the evening of January 8, 1938 with a two day history of abdominal pain. Under a smoothly administered avertin-ethylene anesthesia, a McBurney incision revealed a ruptured appendix with localized peritonitis; appendectomy and peritoneal drainage were performed, and the patient returned to his room in favorable condition. Progress was satisfactory until the early morning of January 11, when, with dramatic suddenness, the patient was aroused from his comfortable state by a sudden fit of painful coughing and labored breathing. Cyanosis rapidly became prominent and his pulse could not be obtained by the nurse. Cardio-respiratory stimulants were administered and the patient was placed in an oxygen tent, with a prompt general improvement of his condition. The immediate temperature of 106°F. (rectal) and pulse of 154 soon fell to 101 degrees and 130, respectively, and remained there. Respirations varied from 36 to 44 per minute. Morphine, parenteral fluids, and an oxygen tent, required without intermission, sustained the patient for the next two days. Portable x-ray and repeated physical examination at this time led to a diagnosis of massive pneumonic processes, involving the entire right lung and one-third of

\* From the private practice of Dr. Edgar Davis, Washington, D. C., whose constant help and advice made this study possible.

the left lung, attributed with question to an aspiration process.

Increasing cyanosis, a rising temperature, pulse, and respiratory rate, and progressive irrationality necessitated a therapeutic bronchoscopy on the evening of the 13th, and 65 c.c. of thick, tenacious, mucopurulent secretions was aspirated from the larynx and both stem bronchi. The inflamed mucosa was shrunken with cocaine-adrenalin solution, leaving both stem bronchi perfectly clear. Upon removal of the bronchoscope the patient volunteered that he felt tremendously improved and that he could breathe much easier. The oxygen tent was discontinued and was never required thereafter. The patient's color improved and remained good throughout the rest of his hospital stay. Roentgen examination thirty-six hours later revealed an absence of all consolidation and only a slight residual infiltration. The temperature dramatically fell to normal by the next morning and remained normal. Pulse and respiration gradually declined to a normal level over a period of four days. Convalescence was rapid and uneventful, and the patient was discharged in ambulatory status on January 22, eight days after bronchoscopy, and fourteen days after admission. Convalescence continued uninterrupted while at home.

*Comment.* Evidently this patient was suffering from a postoperative, bilateral, partial atelectasis, due to plugged bronchi. The onset was early and followed a septic abdominal operation with inadequate emergency preparation. Roentgenograms were misinterpreted and proper treatment was delayed sixty hours. The therapeutic value of bronchoscopic aspiration was dramatically illustrated.

CASE II. A. M., 45 year old Italian chef, male, in previous good health, was admitted to Garfield Hospital, Washington, D. C., on November 20, 1939 with the complaint of a small, incomplete, left inguinal hernia, the result of straining three months before. Physical examination and urinalysis were unremarkable. The next morning a hernioplasty was performed without difficulty under a smoothly administered ethylene anesthesia. The patient reacted favorably and voided, but began to cough lightly. The cough became progressively worse,

with no expectoration, and he complained of growing chest pain. Twenty-four hours after operation he had marked respiratory distress with a chill; he became extremely apprehensive and felt as if he was "suffocating."

On examination, his temperature was 103°F., pulse 140, and respirations 34 per minute. There was some cyanosis of the face and lips, inspiratory dilatation of the alae nasi, and a productive cough. Chest examination revealed the trachea in the midline, no cardiac shift, dullness over the posterior right lung from the scapular spine to the base, with bronchovesicular breath sounds, many subcrepitant râles, and absence of whispering pectoriloquy and bronchophony. A blood count showed 11,400 leucocytes with 74 per cent polymorphonuclears and 5 per cent band forms, 19 per cent lymphocytes, and 2 per cent mononuclears. The sputum contained no type specific pneumococcus, and was thick, tenacious, and blood-tinged.

A diagnosis of postoperative partial atelectasis was made clinically, but a portable chest roentgenogram was reported as a pneumonic process in the lower right lung, despite some narrowing of the ribs and a slight shift of the heart towards the affected side.

The patient was placed on his left side, given no opiates or cough sedatives, and encouraged by his nurse to cough. When this failed to produce bronchial drainage after eight hours, and his condition grew steadily worse, he was bronchoscoped and several thick mucus plugs removed from the right stem bronchi. Immediately afterwards he coughed up several ounces of thick, blood-tinged sputum, and showed immediate improvement. Expectoration continued freely; respirations became easier, and his temperature, pulse, and respirations rapidly fell overnight to 99 degrees, 110, and 30 respectively. Twelve hours after bronchoscopy the chest signs had almost totally disappeared, but he continued to expectorate thick sputum in small amounts for the next forty-eight hours. During this time he received no cough sedatives or opiates, and was encouraged to cough in accordance with a written order. His temperature, pulse, and respirations continued to be normal, and symptomatically he complained only of a mild headache. The remainder of his hospital course was uneventful.

*Comment.* This is another case of atelectasis due to bronchial obstruction, this time

in an aseptic, uncomplicated case. The diagnosis was promptly made by an aware clinician, despite misinterpreted roentgenograms. Early bronchoscopic aspiration removed obstructing mucus plugs and facilitated bronchial drainage by other measures, resulting in a quick resolution of the atelectatic condition.

#### SUMMARY

Because of prevalent misconceptions regarding postoperative pulmonary complications, an effort has been made to stress those salient factors in their etiology and diagnosis which will lead to more effective prophylaxis and treatment. It is the author's opinion that atelectasis is the primary pathologic process, and that pneumonia and lung abscess represent advanced stages of the initial atelectasis. Therefore, the time of onset is of major importance in diagnosis. Bronchial obstruction is the sole determining cause of postoperative atelectasis. The quantity and character of the tracheobronchial secretions, and the forces available for expulsion of these secretions, are the factors concerned in the formation of bronchial plugs. Any agent causing an unfavorable change in either factor may precipitate bronchial occlusion. Most often it is the result of an increased amount of thickened secretions with lessened ability to expel them. If infection is superimposed upon the atelectasis, pneumonitis results. Abscess formation follows if the organism is sufficiently virulent and proper treatment is delayed.

The following factors, involving the tracheobronchial secretions, powers of expulsion of the secretions, and pulmonary infection, have been discussed and evaluated: operative site, operative sepsis, acute and chronic preëxisting respiratory infection, dental sepsis, anesthesia, incisional trauma with resultant muscle-splinting, constricting dressings, with diaphragmatic limitation, immobility, use of morphia, atropine, and cough sedatives, and the predisposing factors of age, sex, and season.

The time of onset has been stressed in diagnosis. Complications appearing in the first five postoperative days are usually atelectasis. Pneumonia seldom occurs prior to the fifth day and most often makes its appearance between the fifth and eighth days. Embolic complications and lung abscesses are usually met after the eighth day. This differentiation is important in the diagnosis of atelectasis from bronchopneumonia, as the clinical picture and even the roentgenogram are often deceptive.

Prophylaxis must be directed towards the prevention of bronchial obstruction and pulmonary infection. Each of the several etiologic factors must be given serious consideration as to its potentiality. The following prophylactic measures have been recommended: preoperative care of the respiratory tract, including the prevention of "colds" after admission; incision and operation as atraumatic as possible; avoidance of tight upper abdominal dressings; an *individualized* anesthetic; judicious use of opiates with preservation of the cough reflex and elimination of pre- and postoperative atropine; semi-Fowler position, supervised deep breathing exercises, and frequent turning after consciousness is regained; encouragement to remove bronchial secretions by cough; carbon dioxide inhalations routinely after abdominal operations; and thyroid extract where the basal metabolic rate is definitely below normal, to prevent embolism.

Only the treatment of atelectasis is presented, for if this condition is treated promptly and efficiently pneumonia and lung abscess will not occur. Mention is made of therapy of embolism. Treatment of atelectasis means removal of the obstruction. Measures used in prophylaxis are also utilized in treatment. In addition, postural drainage, with the aid of cough while in the most favorable position for drainage, is recommended. Bronchoscopic aspiration is strongly recommended when the more conservative methods of drainage fail. Two illustrative cases are presented.



## CONCLUSIONS

1. No one factor is believed responsible for postoperative pulmonary complications. Bronchial obstruction due to a mucus plug and respiratory infection are the most potent factors.

2. Atelectasis, due invariably to a bronchus plugged with mucus, is the basis of most of these complications. Pneumonia and lung abscess represent advanced stages of a primary atelectatic process.

3. Diagnosis in most cases is difficult; roentgenograms are often misinterpreted, and clinical findings are variable. Erroneous diagnosis of pneumonia where only atelectasis exists is frequent. The time of onset is a major consideration in the differential diagnosis.

4. Bronchial drainage, by cough, posture, or bronchoscopy, is essential if atelectasis and its more serious sequelae are to be prevented.

5. Bronchoscopy is a safe procedure in well-trained hands. Its early use when indicated will prevent formation of most lung abscesses.

6. Prophylaxis must not be based on any single etiologic factor; the patient must be considered from every potentiality.

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# THE IMMEDIATE RESTORATION OF ACTIVE EXTENSION OF THE KNEE FOLLOWING FLEXION DEFORMITIES

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THE most common serious deformity in patients with rheumatoid arthritis is fixed flexion of the knee. When the disease has progressed to the subacute or chronic stage and the acute joint pain has subsided the patient frequently discovers that he is unable to stand because of 30 to 60 degrees of flexion deformity of the knee. There is usually 50 to 80 degrees of active and passive motion. X-rays show that the articular surfaces of the tibia and femur would be satisfactory for weight bearing if the knee could be extended normally.

The flexion deformity can be overcome by open lengthening of the posterior capsule and the biceps femoris tendon.<sup>1</sup> Following this procedure the knee can be passively extended to the normal limit. It has been the experience of the author that, following the restoration of full passive extension, the patient usually is unable actively to extend the knee through the final 10 to 20 degrees.

Normal extension of the knee is of no value unless it is under active muscle control. The knee must be held in full extension during that portion of the stride in which the full weight is carried on the extremity. If the patient is unable to do this his gait will be awkward and he will eventually have a recurrence of the flexion deformity.

The lack of complete active extension of the knee is due to overstretching of the patellar tendon during the years in which the knee was held in a flexed position or it is due to adhesions somewhere in the extensor muscle system which will not permit the patella to move far enough proximally to pull the tibia into proper alignment with the femur. Usually both

these causes are responsible. It is impossible to locate or free the adhesions without further damage and scarring to the gliding

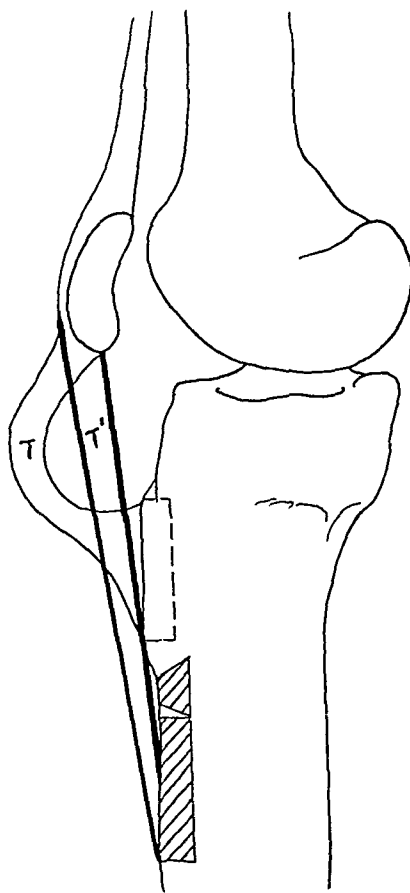


FIG. 1. T, patellar tendon showing laxity. T', patellar tendon after the transplantation of the tubercle of the tibia.

mechanism of the extensor motor apparatus. The transplantation of the tubercle of the tibia by the author's technique offers a solution to the problem and permits immediate full active extension of the knee.

## TECHNIQUE

After the restoration of complete passive extension of the knee an incision is made

extending distally from the lower pole of the patella along the patellar tendon and the upper 3 inches of the anterior-medial

parallel with its lateral border extending from one transverse cut to the other. (1, Fig. 2A.) With the single motor saw

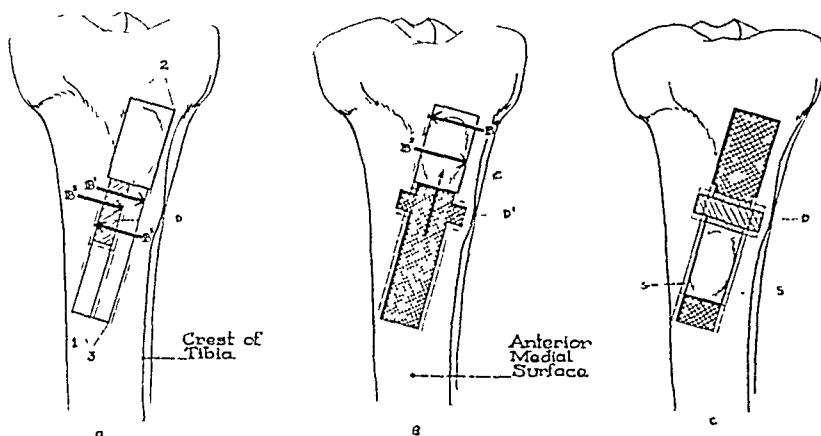


FIG. 2. Anterior-medial surface of the left tibia. A, 1, 2, 3, parallel marks made with twin motor saw. Parallel marks 2 are  $\frac{1}{8}$  inch farther apart than parallel marks 3. B<sup>1</sup>, B<sup>2</sup>, B<sup>3</sup>, B<sup>4</sup>, direction in which the oblique saw cuts are made with the single motor saw. D, dovetail graft  $\frac{1}{4}$  inch wide. B, B<sup>1</sup>, B<sup>4</sup>, direction in which the oblique saw cuts are made with the single motor saw. c, direction of cuts made with the thin osteotome to separate the dovetail grafts from the cancellous bone beneath. D<sup>1</sup>, gutter prepared to receive dovetail graft D. c, tubercle of tibia transplanted distally. The transverse dovetail graft D prevents the tubercle from slipping proximally. The shoulder s of the gutter prevents the anterior displacement of the tubercle.

surface of the tibia. The tendon ( $\tau$ , Fig. 1) is very lax, bulging forward a distance of  $\frac{1}{2}$  to  $\frac{3}{4}$  inch. With the twin motor saw, parallel marks are made on the anterior-medial surface of the tibia extending distally from the tubercle for a distance of 2 inches. (3, Fig. 2A.) These marks are separated by about  $\frac{1}{2}$  inch and penetrate the cortex only far enough to scratch the surface. The distance between the twin saw blades is then increased  $\frac{1}{8}$  inch more and parallel marks are made on either side of the tubercle of the tibia extending from its distal border to the articular surface of the tibia. (2, Fig. 2A.) With the single motor saw, cuts are then made along these marks extending obliquely through the cortex so that the bone between the parallel cuts forms a dovetail (B<sup>1</sup> and B<sup>2</sup>, Fig. 2A, B<sup>3</sup> and B<sup>4</sup>, Fig. 2B). A transverse cut is then made across the dovetail just distal to the tubercle and another 2 inches below this across the distal end of the dovetail. With the twin motor saws separated by  $\frac{1}{4}$  inch, a mark is made on the dovetail

this cut is continued obliquely through the cortex, medially, to form a narrow dovetail. (B<sup>5</sup>, Fig. 2A.)

With a thin osteotome the cortex between the parallel cuts is then freed from the cancellous bone beneath (c, Fig. 2B) and the portion between the transverse cuts removed. By the same technique a transverse gutter is prepared (D<sup>1</sup>, Fig. 2B) to receive the small dovetail graft (D, Fig. 2A.) The tubercle is then displaced distally a distance of  $\frac{1}{8}$  inch for each 10 degrees of fixed flexion which was present before the posterior capsulotomy operation and the  $\frac{1}{4}$  inch wide dovetail (D, Fig. 2c) placed transversely across the gutter proximal to the tubercle.

The double dovetail technique holds the tubercle solidly in its new position and prevents its displacement anteriorly and proximally.

This method of transplantation of the tubercle of the tibia requires a very accurate cabinetmaker's fit between the dovetail grafts and the gutters into which

they are inlaid. The parallel marks made on either side of the tubercle are  $\frac{1}{8}$  inch farther apart than those for the gutter into which the tubercle is to be inlaid to allow for the sawdust lost in cutting the dovetails. This insures a tight fit. As soon as the transverse dovetail is in place full active and passive flexion and extension of the knee can be started without fear of avulsion of the transplanted tubercle.

#### SUMMARY

1. After the restoration of normal passive extension in fixed flexion deformities of the knee the patient is frequently unable actively to extend the knee through the final 10 to 20 degrees.

2. Transplantation of the tubercle of the tibia distally  $\frac{1}{8}$  inch for each 10 degrees

of fixed flexion deformity which was present before the posterior capsulotomy operation restores full active extension of the knee.

3. A new technique for transplantation of the tubercle is presented. By this method the tubercle is held in place by double dovetails.

4. This technique permits immediate active extension of the knee to the normal limits and eliminates the necessity of waiting three or four weeks for callus to unite the transplanted tubercle to the tibia.

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# UNEXPECTED OCCURRENCE OF SUGAR IN THE URINE FOLLOWING GLUCOSE INFUSIONS\*

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IN a far larger percentage of cases than is ordinarily realized, sugar can be demonstrated in the urine of patients soon after they have been given intravenous infusions of glucose. This is so even though the usually accepted tolerances for sugar have not been overstepped at any time during the infusion and, indeed, occasionally though the maximum tolerated dose of sugar has not even been approached. This phenomenon, which has apparently plagued careful observers<sup>1</sup> seems explicable on the basis of available experimental observations, though this statement is by no means meant to imply that the entire story of glucose metabolism is yet known.

*Utilization of Sugar.* Under conditions of glucose administration short of the production of glycosuria all of the administered glucose is considered to be "utilized." Maximal administration of glucose in the absence of glycosuria produces a condition of maximal utilization.

When maximal utilization is occurring there is acceptable evidence, based on the measurement of heat production, that from one-quarter to one-third of the administered glucose is immediately oxidized to carbon dioxide and water, whereas the remaining two-thirds to three-quarters, although it ultimately undergoes oxidation, is first stored in the body in one form or another for a variable period of time.<sup>2</sup> Most of the storage is generally believed to occur in the form of glycogen, but conversion to other compounds is not only chemically possible but physiologically practically certain—conversion to fat, to lactic acid, and to other substances

such as hexosephosphate, glycerophosphate and glucosamine.

Thus "utilization" is a term which is equivalent to "oxidation" in the long run, but as far as shorter periods of time are concerned includes both "oxidation" and "storage."

*Glucose Tolerance.* When glucose is administered in larger quantities, i.e., at faster rates, than it can be utilized by the body the excess is excreted in the urine. Under such conditions utilization can be computed by subtracting the quantity of sugar appearing in the urine from the total quantity of sugar administered during any particular period of time. On the assumption that glucose added directly to the blood stream by artificial means is treated by the body in no essentially different manner from that which is absorbed in the natural way from the intestine, and by using an accurately metered pump, constant rates of injection, and the intravenous infusion technique, it is possible to determine accurately the rate of glucose administration which produces maximal utilization. Thus has been established the widely quoted and generally accepted dictum that glucose can be completely utilized if the rate of administration does not exceed about 0.85 Gm. per Kg. of body weight per hour<sup>3</sup> and that techniques which do not exceed such a rate of administration can be used in full confidence that the critical level of sugar in the blood will not be exceeded and therefore sugar will not appear in the urine.

Obviously, direct addition of glucose to the blood stream, as in intravenous infusion, constitutes a highly artificial situation against which the body's defenses

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have not been developed by ordinary evolutionary processes; thus a patient's glucose tolerance is quite at the mercy of the infusion technique. Whether the absorption rate from the intestine is great enough to produce "alimentary glycosuria" in normal individuals is a disputed point. Apparently the absorption rate in some species may be as high as 1.6-1.7 Gm. per Kg. body weight per hour, but even at this high rate of absorption glycosuria does not occur.<sup>4</sup> At present the consensus of opinion seems to regard the occurrence of "alimentary glycosuria" as always an evidence of impaired tolerance.

The magnitude of the rise in blood sugar level after measured, oral or intravenous administration of glucose, the time relationships of the initial rise and subsequent fall in the blood sugar level, the amount of sugar which appears in the urine, and the proportions of the retained sugar which are on the one hand oxidized and on the other hand stored, all conform to certain general standards which form the basis for the familiar "glucose tolerance tests."

This much of the story of glucose metabolism is quite familiar to all students of the subject, but it does not seem to be widely appreciated that the above-mentioned concepts hold good only for a body in a relatively normal functional state. The particular considerations which do not seem to have been sufficiently emphasized are: (1) that abnormal reactions may be expected under conditions of gross imbalance between the secretions of the endocrine glands controlling carbohydrate metabolism, viz., pancreas, pituitary gland, adrenal glands; (2) that glucose utilization and glucose tolerance vary somewhat widely with the stage of nutrition; and (3) that glycosuria or lack of glycosuria is in part dependent upon the function of the kidneys and particularly upon the magnitude of diuresis.

Unfortunately it does not seem possible at the present time, in spite of a multitude of experimental investigations on the endocrine control of carbohydrate metabo-

lism, to discuss profitably the part which may be played by unrecognized endocrine imbalance in the production of glycosuria after glucose infusions. This is true not only because the interrelationship of the various endocrine secretions is still much in dispute but also because no sufficiently simple and practical means has yet been devised for rapid routine assay of the endocrine balance of the individual patient. Fortunately, at least as far as this discussion goes, however, it does not seem necessary to invoke any such complicated hypothesis to explain most cases of post-infusion glycosuria. The known effect of the pre-infusion level of pancreatic activity on the utilization of infused glucose alone seems adequate to account for the major portion of the cases.

*The Effect of Nutrition on Sugar Utilization and Glucose Tolerance.* That undernutrition and starvation depress glucose utilization has been appreciated in a general way since 1873, the year in which Lehmann demonstrated that rabbits, previously fasted for two or three days, exhibited glycosuria following intravenous injection of sugar in amounts which caused no glycosuria in animals which had been regularly fed.<sup>2</sup> Hofmeister in 1890 confirmed the observation that fasting or under-nourished animals show impaired glucose assimilation and gave to the condition the name "hunger diabetes."<sup>2</sup>

With this observation as a point of departure and after much experimental observation the thesis has been gradually developed that sugar utilization is very definitely a biologic variable. When the body is in nutritional equilibrium the utilization of carbohydrates by the tissues shows a relatively exact automatic adjustment to the supply of sugar. Under these conditions not only is there both an adequate supply of glucose and an adequate utilization thereof, but periods of moderate increase of supply are followed by corresponding periods of increased utilization. If, on the other hand, the body has been conditioned by a moderate period of

fasting to diminished sugar utilization, and sugar is now administered in moderate amounts the decreased tolerance established by the interval of fasting becomes manifest in the development of a hyperglycemia which not only attains its maximum more rapidly than normal but attains a higher value as well. Furthermore, if the period of diminished carbohydrate supply or actual fasting exceeds a certain critical value, the hyperglycemia which follows subsequent administration of glucose will be great enough to exceed the kidney threshold for glucose and one or another degree of glycosuria will result. In this connection it should be emphasized that the loss of sugar which occurs is in spite of the need of the body for the glucose thus being wasted.

If one continues to supply glucose beyond this point indefinitely, i.e., if the period of fasting is brought to a close, glucose utilization may be expected, other things being equal, to increase progressively and ultimately regain its normal level. The glycosuria is transient and disappears as soon as the rate of utilization increases to a point where the blood sugar level is kept within suitable bounds. In short, the body returns to its normal carbohydrate equilibrium. Peculiarly enough, however, if the opposite course is pursued, if carbohydrate administration is stopped, and starvation is allowed to progress, the response to short periods of glucose administration under such conditions shows no further lessening of carbohydrate utilization, but on the contrary an enhancement. The explanation undoubtedly is that as food curtailment passes over into actual starvation carbohydrate tolerance actually improves because a new source of carbohydrate is made available by virtue of conversion of the body's own protein to sugar. As long, therefore, as endogenous protein is being converted to carbohydrate the ability of the body to utilize sugar is to some extent anomalously regained. Terminally, of course, carbohydrate utilization per-

manently diminishes as the supply of available protein becomes exhausted, but this is not particularly pertinent here.

The point which is of the utmost significance in the present discussion is that complete deprivation of carbohydrate food for short periods of time, or curtailment of the supply of such food over a longer period of time profoundly alters the utilization of glucose and predisposes the body to the elimination of sugar in the urine when carbohydrate administration is resumed even though the amount of carbohydrate is considerably less than that required to produce glycosuria normally. In short, the moderately sick person whose food supply has been curtailed or completely cut off for a short time because of alimentary derangements and who is likely therefore to be given glucose parenterally is precisely the person most likely to show "unexplained" glycosuria. The person who has undergone more prolonged glucose curtailment is not so likely to show glycosuria.

*The Effect of Diuresis on Glucose Utilization and Glycosuria.* Inasmuch as the parenteral administration of glucose inevitably involves concomitant administration of water, the glucose necessarily being given in the form of a solution, the question naturally arises whether the degree of dilution of the infused glucose makes any difference in its utilization. If the answer to this question could be given with assurance it would throw light on the possibly important practical decision whether to administer glucose in any given case in concentrated form or in more generous dilution.

This matter has received but scant attention, partly no doubt because of the technical difficulties involved in devising crucial experiments. Not only does a period of preliminary curtailment of glucose diminish the utilization of the substance when it is subsequently administered, as has been previously described, but preliminary administration of glucose even for a short period of time increases the

utilization of this substance as its administration is continued. This phenomenon has been called "priming." The most obvious explanation is that the islet cells of the pancreas are capable of elaborating the substance which controls the level of blood sugar, insulin, at various levels of activity. Thus, if these cells happen to be functioning at some particular relatively low level and glucose is suddenly supplied in quantity the level of insulin elaboration may be temporarily insufficient to produce complete utilization and glycosuria occurs. If, however, glucose continues to be supplied in not too great quantity insulin elaboration is stimulated, utilization becomes stabilized at a higher level and glycosuria disappears.

Until recently there has been no good evidence that the dilution of administered glucose significantly affects utilization. Only one animal from the experiments of the earlier workers with the constant or metered-pump method of administering glucose solutions showed results capable of interpretation from this point of view and the protocol from this animal seemed to indicate that the dilution of the glucose did not affect either utilization or excretion, but on the other hand, the degree of diuresis was not great.<sup>5</sup> A later worker was able to conclude from a series of experiments in which 5 per cent to 80 per cent solutions of glucose were used as infusion vehicles that the administration of much water along with the glucose, though it promotes diuresis, increases retention of glucose in the body and thus tends to prevent glycosuria.<sup>6</sup> At a given level of blood sugar, however, it was concluded by this worker that when more water is available more glucose is excreted in the urine.

When conditions are carefully controlled, it lately seems to have been shown experimentally that great diuresis definitely decreases glucose utilization, i.e., both decreases the quantity of glucose retained in the body and increases the quantity of glucose lost in the urine.<sup>7</sup> In

order to make the findings conclusive it was necessary to stabilize the activity of the islet cells of the pancreas at a high level by initial priming with glucose solution at a constant rate of injection and then, without changing the rate of glucose injection, to add large quantities of saline solution also at a constant rate.

Glycosuria, due to diuresis, probably does not represent any alteration of carbohydrate metabolism but, instead, is dependent upon increased filtration through any given glomerulus and perhaps also the opening of previously inactive glomeruli. There is evidence that the kidney tubules are able to reabsorb from the tubular urine only a certain maximal quantity of glucose per unit interval of time. If the glomeruli pass a filtrate so rich in glucose that tubular reabsorption is inadequate to restore it all to the blood stream or if the quantity of filtrate is so great that its sojourn in the tubules is too short to permit complete reabsorption, glycosuria results.

At all events, if the experimental results can be accepted it seems that the amount of glucose excreted in the urine during an infusion may be increased as much as ten times by diluting the infusate without changing the rate of administration of the glucose as such.

#### CONCLUSIONS

1. In general the presence of glucose in the urine of a patient is an indication that there is more sugar in the blood stream of that patient than the body can immediately oxidize or store, i.e., more than the body can "utilize."

2. In nondiabetic subjects and under ordinary or normal conditions of nutrition utilization is at a fairly uniform level from person to person. The limits of utilization are probably never exceeded in such circumstances if glucose is added to the blood stream whether from the gastrointestinal tract or parenterally in amounts not exceeding 0.75 Gm. per Kg. body weight per hour.



3. Ability of the body to utilize glucose, however, is markedly affected by the amount of glucose which has been available previously; thus a period of glucose curtailment or denial (starvation) decreases the ability of the body to utilize this substance subsequently, and conversely the administration of moderate amounts of glucose during a preliminary period of time enhances the utilization of this substance subsequently.

4. Most patients who receive glucose parenterally are given this substance precisely because they have shown themselves incapable of taking, through natural channels, carbohydrate food over a period of time preceding the decision to make up the deficit artificially. Such patients are more than likely to exhibit diminished capacity for glucose utilization, and if they are treated as if they can utilize the substance as fast as normal individuals, they may be expected to develop glycosuria.

5. Inasmuch as the mere administration of glucose over a period of time, probably by stimulating the internal secretion from the cells of the islands of Langerhans, increases the level of glucose utilization, a patient who shows initial slight glycosuria during suitable parenteral administration of a solution of glucose may cease to show sugar in the urine after his utilization level has been restored to normal by the judicious continuation of the administration.

6. Inasmuch as excessive diuresis may cause the appearance of sugar in the urine in cases in which glycosuria would not otherwise appear, and may increase the elimination of sugar in cases in which the elimination of sugar would otherwise be less, glycosuria is more likely to occur and occur more extensively in those cases in which glucose is administered in dilute solution or in conjunction with large quantities of saline solution.

7. There is good experimental precedent, therefore, for individualizing cases in the parenteral administration of glucose solu-

tions in order to avoid glycosuria. When patients are in a state of partial glucose starvation, as most sick patients are, it is suggested that they be regarded as having an abnormally decreased ability to utilize this substance and accordingly that they be given only moderate amounts of 5 per cent solutions, or perhaps, better still, 10 per cent solutions for several hours in an attempt to build up their level of utilization, before resorting to the administration of more dilute solutions of glucose or quantities of saline solution to combat associated dehydration. The rate of administration of glucose might well be kept for some hours at not much more than half the maximal accepted rate for persons in a normal state of nutrition, i.e., 3, 4 or 5 Gm. per Kg. body weight per hour. On the other hand, if the combating of dehydration rather than the administration of glucose for nutritional purposes is the pressing indication, it might be preferable to confine one's parenteral administration initially to saline solutions for several hours, thereafter building up a suitable tolerance for glucose gradually by interspersing periods of relatively slow administration of 5 to 10 per cent solutions of glucose alone.

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# CIRCULATION TIME IN SURGICAL PATIENTS\*

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EVER since Sir William Harvey's<sup>1</sup> epochmaking description of the circulation of the blood in 1628, the matter of blood velocity, or its inverse ratio, circulation time, has been investigated by a number of workers. We have studied circulation time by the sodium cyanide method in a large number of surgical patients. Our endeavor has been to find what value, if any, this test has from a prognostic standpoint in surgical morbidity or mortality.

Blumgart,<sup>2</sup> in his extensive monograph, has given an excellent historical survey covering in detail all investigation up to the time of his publication. A brief résumé of the work on circulation time to date is here presented.

Hales,<sup>3</sup> in 1733, computed the velocity of blood flow from his estimation of the capacity of the left ventricle, the diameter of the base of the aorta and the pulse rate. The same investigator made microscopic observations on the capillaries of the lungs in experimental animals and estimated blood velocity there by this means.

Hering,<sup>4</sup> in 1827, injected potassium ferrocyanide into the jugular vein of a horse and measured circulation time by noting the time of the appearance of the ferrocyanide in the opposite jugular. His average jugular to jugular circulation time in horses was 26.2 seconds.

Volkman,<sup>5</sup> in 1850, described the use of the hemodromometer which gauged blood velocity by recording the movement of a pendulum placed in the lumen of a blood vessel.

Vierordt,<sup>6</sup> in 1858, designed his hemotachometer. He modified Hering's method and worked on rabbits, cats, dogs and other experimental animals. It was his impression

that circulation time is related to pulse rate, and from such observations in animals estimated the jugular to jugular circulation time in man to be 23.1 seconds if the heart rate were 72.

Stewart,<sup>7</sup> in 1893, injected hypertonic saline intravenously into one jugular vein and measured circulation time by noting electrical conductivity changes in the blood in a vascular bed at a distance from the site of injection. He also injected methylene blue into one vein and timed its appearance by transillumination in the opposite carotid artery.

Bornstein,<sup>8</sup> in 1912, had patients breathe 7 per cent carbon dioxide and measured the time for the patient's respirations to quicken. He estimated that this was half the circulation time. This deduction was based on the fact that the time as measured was the time necessary for the carbon dioxide to travel from the pulmonary bed to the respiratory center or approximately half the total circulation.

Loevenhart, Schlomowitz and Seybold,<sup>9</sup> in 1922, measured the circulation time in rabbits and dogs with sodium cyanide. The same workers reported on the use of lithium salts, hexamethylene and ferrocyanide. Koch,<sup>10</sup> in 1922, injected fluorescein and noted the time of arrival in the opposite forearm by drawing repeated blood samples. Hirschsohn and Mandel,<sup>11</sup> in 1922, injected calcium chloride and took as their end point a sense of warmth or burning in the throat.

Blumgart and Yens,<sup>12</sup> in 1927, described their method of injecting a radioactive substance and noting its appearance in various parts of the cardiovascular bed by radiographic means. This method, though highly technical, allowed for measurements in

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parts of the circulation. Weiss, Robb and Blumgart,<sup>13</sup> in 1929, injected histamine and noticed its peripheral vasodilator effect to measure circulation time.

Klein and Heineman,<sup>14</sup> in 1929, reported on a method similar to that of Koch<sup>10</sup> but used congo red instead of fluoresceine. Winternitz, Deutsch and Brull,<sup>15</sup> in 1931, injected sodium dehydrocholate and took as their end point the appearance of a bitter taste. Tarr, Oppenheimer and Sager,<sup>16</sup> in 1933, reported on the use of the same material in a variety of medical conditions. Robb and Weiss,<sup>17</sup> in 1933, reported on the use of sodium cyanide to measure circulation time in man. This work will be mentioned in detail below.

Fishberg, Hitzig and King,<sup>18</sup> in 1933, reported on the injection of saccharin and timed their patients by the appearance of a sweet taste. Hitzig,<sup>19</sup> in 1934, reported on the injection of ether. By noticing the odor of ether on the patient's breath, he measured the circulation time for the lesser or pulmonary circulation. Goldberg,<sup>20</sup> in 1936, injected calcium gluconate and timed the circulation in various regions by having the patient report on the appearance of a burning sensation in the pharynx, face, chest, perineum, hands and feet.

An ideal method of measuring circulation time on a busy surgical service falls within rather narrow bounds. It should be inexpensive. It should be easily performed by the average house officer on a surgical service. It should not entail the use of instruments or devices uncommon to a surgical ward. Injection of a chemical into the antecubital veins falls well into line. The material should be nontoxic. It should not, of itself, influence the rate of blood flow. The reaction should produce objective and not subjective signs. The reaction time compared to the circulation time should be minimal, or better, negligible. (It is to be noted that the circulation time, as measured, is the time in seconds from the time of injection to the appearance of the objective reaction. This includes the time consumed in producing the objective reaction after

the material has arrived at a given point.) The reaction should be short-lived to allow for frequent repetition. It must not produce any element of fear in the patient. The reaction should occur without relation to the presence or absence of morbid states in the body.

Sodium cyanide, in proper dosage, has been found to fit very closely the requirements here presented. As early as 1828 Ryan<sup>21</sup> described the use of sodium cyanide as a respiratory stimulant. Loevenhart, Lorenz, Martin and Malone,<sup>22</sup> in 1918, reported on the stimulation of respiration by sodium cyanide. They found the dose necessary to produce respiratory stimulation to be, in an adult, about 3 to 5 mg. which was equivalent to about 0.04 to 0.07 mg. per Kg. of body weight. Experimenting with dogs, they found the fatal dose of sodium cyanide to be about twenty times the therapeutic dose. They estimated that this relation probably holds true for man. They state that sodium cyanide is destroyed in man at the rate of 1.5 to 2.0 mg. per minute. It is converted into innocuous sulfur compounds and nitrogen compounds. It is excreted in the breath as hydrocyanic acid and in the urine as cyanide and sulfocyanide.<sup>23</sup> Robb and Weiss, mentioned above, studied the use of sodium cyanide to determine circulation time in man. They found that doses of 0.11 mg. per Kg. of body weight were safe and effective. Such dosage produced a definite objective end point—a mild increase in respiratory rate and a marked increase in amplitude of respiration. Toxic doses in animals will produce first a fleeting stimulation of respiration which is followed quickly by a rapid, shallow and irregular respiration followed by respiratory paralysis and death.

Heymans, Bouchaert, and Dautreband<sup>24</sup> and Owen and Gesell<sup>25</sup> state that the action of sodium cyanide in stimulating respiration is on the carotid sinus and not on the respiratory center. Their evidence in support of this finding is a series of denervation experiments on animals. Tschibukmacher<sup>26</sup> in an elaborate anatomic dissection of the

carotid sinus nerve and its connections describes pathways between the carotid sinus nerve and the vagus. It may be over such a pathway that impulses travel to produce the respiratory response. Robb and Weiss support the view that action is on the carotid sinus, also by indirect evidence. They measured, simultaneously, cyanide time and the time required for glucose to reach the femoral artery when both are injected in one solution. For the details on this work we refer the reader to the original article.

We conducted about 800 circulation time tests on about 500 surgical patients of all types whose ages ranged from 10 to 85 years. We varied our dosage with weight in the first fifty cases, but found little indication for so doing and decided on three definite doses to be used throughout: 8 mg. for males, 6 mg. for females and 4 mg. for children. We used a 2 per cent solution and thus were injecting 0.4 c.c., 0.3 c.c. and 0.2 c.c. in men, women and children, respectively. We injected routinely into the right antecubital vein and used a tuberculin syringe. With very few exceptions, manual compression was used instead of a tourniquet. The patient was always lying flat in bed, head on one pillow, with the right arm at the level of the auricles. We found that time of day did not affect results, nor did the proximity to meals have any effect. Our injection time was always under one second.

In almost 100 cases we measured blood pressure before and after taking circulation time measurements. We found no substantial change at any time, before or after. There was some increase in pulse rate, up to about ten beats per minute (except in cases of hyperthyroidism where the increase averaged eighteen beats per minute) for a short while after the test. This in most instances in our experience was concomitant with an expression of anxiety and may have been on a psychogenic basis. Some of our normal subjects were senior medical students who watched the investigation in ward patients and understood the proce-

dure. In these cases there was no appreciable change in pulse rate. We experienced no untoward reactions in the entire series. When it was desired to repeat the test, in no case was the patient unwilling to undergo repetition.

To gain some degree of facility in recognizing the end point early in this series, values were accepted only, when on repetition on the test, the results checked within two seconds. In 130 healthy, adult subjects\* ranging in age from 20 to 40 years, our average circulation time was 17.0 seconds, with readings ranging from 10 to 26 seconds. Robb and Weiss report as their average in healthy normals 15.6 seconds with values ranging from 9 to 21 seconds. Weiss, Robb and Blumgart, using 0.001 mg. of histamine phosphate per Kg. of body weight (in 1:5000 solution) and using a flushing of the face as their end point, report sixty-five normals averaging 23 seconds with readings ranging from 13 to 30 seconds. Their explanation for the discrepancy (6.5 seconds in recorded experiments) is that the cyanide time measures time from the periphery to a large vessel (the carotid artery) whereas histamine measures the time to a more peripheral site and includes passage through the capillary bed to the venules, where the histamine acts. However, Tarr, Oppenheimer and Sager using sodium dehydrocholate averaged 13 seconds and Goldberg using calcium gluconate averaged 12.5 seconds for normals. Their points of action were the peripheral neural end organs in the pharynx.

In reviewing our figures, we noted some correlation between circulation time by the cyanide method and the subjects' age. Table 1 is an analysis on an age basis, including all subjects examined. The only prognostic significance here presented is the scientific evidence of a generally increasing circulation time with advancing years. It simply supports the view that early general

\* In the "normal" group were medical students and patients not seriously ill, admitted with such conditions as contusions and abrasions, sprained ankles, simple inguinal hernia and the like. Robb and Weiss included similar patients in their normals.

motion in postoperative patients of advanced years is advisable if we are to avoid the dangers consequent upon stasis.

TABLE I  
RELATION OF AGE TO CIRCULATION TIME

Age Group, Years	No. of Cases	Average, Seconds	Range, Seconds
10 to 19	80	13.0	8 to 22
20 to 29	105	16.0	10 to 22
30 to 39	105	17.1	10 to 22
40 to 49	100	18.9	10 to 27
50 to 59	190	21.9	12 to 34
60 to 69	110	25.0	13 to 37
70 to 79	50	23.0	14 to 34
80 to 85	20	27.0	18 to 35

It is of interest to quote here from Harvey's<sup>1</sup> work: "The circuit of the blood is accomplished now more rapidly, now more slowly according to temperament, age, . . . of the individual . . ."

Analysis of our records on the basis of general type of disorder including all age groups is given in Table II. Inflammatory

TABLE II

Type of Disorder	No. Cases	Average, Seconds	Range, Seconds
Inflammatory conditions. . .	320	17.8	10 to 37
Traumatic conditions. . . . .	290	19.0	8 to 35
Neoplastic conditions. . . . .	80	21.3	10 to 36
Peripheral vascular disease. .	60	22.0	17 to 28
Hyperthyroidism. . . . .	15	8.9	6 to 12
Patients with various surgical conditions whose E.-K.G. read—were normal.	30	25.2	13 to 40

conditions included such an expanse as suppurative adenitis in children of 10 to carbuncles in diabetics of 70. Traumatic conditions included fractured hips in many elderly patients and various types of fractures in children. Neoplastic conditions were, with the exception of one male, age 23, with inoperable carcinoma of the rectum, all in the age groups above 40. Peripheral vascular disease included such conditions as Buerger's disease, Raynaud's disease, diabetic arteriosclerosis, senile ar-

teriosclerosis and traumatic gangrene of the foot following fracture of the leg. These patients were for the most part past the 40-year age group. The abnormal electrocardiogram readings included such interpretations as: myocardial fibrosis, myocardial damage, sinus tachycardia, auricular fibrillation and healed infarct from coronary occlusion. These were also in the older age groups.

During the time of this investigation there were two wound disruptions, (both in peptic ulcers which had been ruptured six hours prior to operation) and ten wound infections. Investigation of the circulation time in these cases revealed that circulation time adhered to the average for the age group within 10 per cent. In this same period there were seven patients with pulmonary complications following general anesthesia. Their circulation times were normal both before operation and after the subsidence of their pulmonary complication. In this regard Brandt<sup>27</sup> reports 153 patients with pulmonary tuberculosis with an average circulation time by the saccharin method of 12.73 seconds. Patients who had particularly stormy postoperative courses were compared with patients whose postoperative courses were uneventful. There was no essential difference in circulation time. Review of the circulation time of those patients who died as the result of their operations or complications indicated no unusual findings.

Patients in cardiac decompensation or with cardiac histories and impending decompensation were not admitted to this service. We offer no data on such patients.

#### DISCUSSION

Our values for circulation time seem to be a bit higher than those of other workers using this method and also higher than results obtained by most other injection methods. Our study was aimed at determining the prognostic value of this test. The same end point was used in all cases. Hence our values are of significance regardless of the base line for normal.

## SUMMARY AND CONCLUSIONS

1. Many methods for measuring circulation time are reviewed.
2. The injection of a substance into a peripheral vein for determining circulation time appears to be an ideal method for a large series of tests.
3. The attributes of an ideal substance for injection are stated.
4. Sodium cyanide in proper dosage conforms to this ideal.
5. The pharmacology of sodium cyanide as it relates to its use in circulation time measurement is presented.
6. The test has been applied to about 500 patients about 800 times.
7. Our average values are slightly higher than those of other observers.
8. There is a correlation between age and circulation time, according to our figures, that is, the circulation time increases with age. The average rate in the age group for 80 to 85 years is twice that for the age group 10 to 20 years.
9. This test does not afford any prognostic significance in surgical patients either from the morbidity or mortality standpoint.

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# PRACTICAL APPLICATION OF THE FALLING DROP METHOD FOR DETERMINING SURGICAL PROGNOSIS\*

## PRELIMINARY REPORT

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THE proper administration of fluids in cases of dehydration, edema and shock has been and is a vexing problem. Various methods for the maintenance of proper fluid balance are at present employed, but most of these are inadequate, and dehydration or edema may still suddenly develop in any case under treatment.

We have devised a method for determining the status of the fluid balance which can be carried out in a few minutes by a trained intern or laboratory staff member. Tissue and pulmonary edema and massive internal hemorrhage can be predicted twenty-four to forty-eight hours before they appear clinically. When plasma protein (which follows accurately the specific gravity of the plasma as well as that of whole blood) approaches the so called "critical level" of 5.5 Gm. per cent, oncoming edema should be suspected. Edema will appear if the reading goes below that level, although it may be several days after this level is reached before edema is clinically apparent. When the critical level is reached, however, fluids should be stopped and a small blood transfusion given. This prevents the development of edema and returns the specific gravity of the blood, the plasma, and the blood protein to their respective normals.

It is now generally accepted that the specific gravity of whole blood and blood plasma varies with the degree of dehydration, edema, shock, or hemorrhage. The first attempt to measure the specific gravity of whole blood was made in the seventeenth century by Robert Boyle. Since then numerous other methods have been devised. In 1924, Barbour and Hamilton<sup>1</sup> described

a simple method of measuring the specific gravity of whole blood, blood plasma, and other body fluids. This method is considered by many to be the most practical to date. It is based upon the principle that the time required for a drop of a certain volume of fluid to fall a fixed distance through a liquid (bromobenzenexylene solution) depends upon the density of the drop and that of the fluid through which it is falling. This is compared with a determination which is made with a standard solution of potassium sulfate of known density, the specific gravity of which closely approximates that of normal whole blood. The density of the bromobenzenexylene solution is adjusted so that the falling time of the drop of blood is from 20 to 60 seconds. The drop of blood must be 0.01 ml. by volume and the distance of the fall 30 cm.

The normal average value of the specific gravity of whole blood as determined by this method is 1.0566 for males and 1.0533 for females. The maximum concentration usually occurs in the morning, varying about 0.0033 during the course of the day.

The specific gravity of blood plasma is determined by the same method. Plasma is best obtained by adding approximately 5 mg. of heparin to 5 c.c. of venous blood. The heparinized blood is centrifuged and the supernatant fluid is used for the determination. The specific gravity of normal plasma, as determined by this method, is 1.0270 which corresponds to a plasma protein of 6.83 Gm. per cent.

Moore and Van Slyke<sup>3</sup> showed the constant relationship between the specific gravity of blood plasma and the plasma protein

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content in the edema of nephritis. This was essentially confirmed by the studies of Weech, Reeves, and Goettsch.<sup>4</sup> They established a formula from which the values of plasma protein could be derived from the determination of the specific gravity of the plasma: (plasma specific gravity 1.0069)  $\times$  340.1 = plasma protein.

The present investigation was undertaken to determine the practical application of the Barbour and Hamilton method for the determination of the specific gravity of whole blood and blood plasma as a clinical aid in diagnosis, prognosis, and treatment of patients at the Cumberland Hospital who presented evidence of shock, edema, dehydration or hemorrhage.

TABLE I  
NORMAL VALUES

Specific gravity of whole blood.....	Male	1.0566
	Female	1.0533
Specific gravity of plasma.....		1.0270
Plasma protein.....		6.83 Gm. per cent
Critical level of plasma protein.....		5.5 Gm. per cent

The specific gravity of whole blood and of blood plasma is increased in dehydration and shock. It is decreased in hemorrhage and edema.

CASE I. E. M., white, male, age 70, entered the hospital with signs and symptoms of a gastric malignancy. A subtotal gastrectomy was performed on November 21, 1938. The blood studies in this case were as follows:

Date	Sp. Gr. of Blood	Sp. Gr. of Plasma	Protein Gm. Per Cent	Edema
Nov. 21.....	1.0528	1.0241	5.85	—
22.....	1.0531	1.0222	5.21	—
23.....	1.0507	1.0230	5.48	—
24.....	1.0459	1.0217	5.02	+
25.....	1.0468	1.0225	5.31	+

On November 21, 1938 this patient had a plasma protein of 5.85 Gm. per cent. With the administration of fluids parenterally there was a sustained fall of the specific gravity of whole

blood and blood plasma. Clinical edema was noted on November 24, 1938. The plasma protein as calculated from the specific gravity of plasma was 5.21 Gm. per cent (below the critical level of 5.5). The appearance of edema in this case could have been predicted at this time, forty-eight hours before it appeared clinically.

CASE II. C. M., white, female, age 28, entered the hospital with extensive second and third degree burns of the face, extremities and back. Blood transfusions and fluids were given parenterally. The findings in this case were as follows:

Date	Sp. Gr. of Blood	Sp. Gr. of Plasma	Protein Gm. Per Cent	Edema
Nov. 1.....	1.0485	1.0211	4.83	+
2.....	1.0457	1.0225	5.31	+
3.....	Blood transfusion			
4.....	1.0560	1.0278	7.11	—

Following the blood transfusions the disappearance of edema and the rise in plasma protein above the critical level is striking.

CASE III. J. A., white, male, age 54, entered the hospital after several past unsuccessful operations for the relief of gastric ulcer. On October 26, 1938 a subtotal gastrectomy was performed. The blood studies after operation were as follows:

Date	Sp. Gr. of Blood	Sp. Gr. of Plasma	Protein Gm. Per Cent	Edema
Nov. 1.....	.....	1.0248	6.09	—
2.....	.....	1.0249	6.12	—
21.....	1.0605	1.0261	6.53	—
23.....	1.0474	1.0245	5.99	—
25.....	1.0435	1.0226	5.34	+
29.....	1.0507	1.0264	6.63	Slight
Dec. 7.....	1.0472	1.0248	6.09	Slight

This patient had a stormy postoperative course and was unable to retain anything by mouth. He soon developed a state of marked dehydration. The specific gravity of whole blood on November 21, 1938 was 1.0605 (normal sp. gr. 1.0550). With the continued ad-



ministration of fluids the specific gravity of whole blood and blood plasma fell, and on November 25, 1938, when the plasma protein fell to 5.34 Gm. per cent, edema developed. Tissue edema could have been predicted twenty-four to forty-eight hours before it appeared.

CASE IV. M. DeC., white, male, age 48, entered the hospital on November 14, 1938 because of a bleeding duodenal ulcer for which he had been operated upon twice during the last fifteen years. A subtotal gastrectomy was performed on November 23, 1938. The blood findings before and after operation were as follows:

Date	Sp. Gr. of Blood	Sp. Gr. of Plasma	Protein Gm. Per Cent	Edema
Nov. 21	1.0557	1.0250	6.15	—
23 A.M.	1.0522	1.0247	6.05	—
P.M.	1.0552	1.0251	6.19	—
24..	1.0541	1.0247	6.05	—
25 A.M.	1.0494	1.0252	6.22	—
P.M.	1.0509	1.0245	5.99	—
26..	1.0470	1.0230	5.48	—
27..	1.0433	1.0231	5.52	+
28..	1.0412	1.0217	5.03	+

The specific gravity of whole blood and blood plasma was maintained by the administration of a fairly large amount of fluid parenterally on November 23 and 24. However, a sudden fall in the specific gravity of whole blood was noted the following day. Since the fluid administered was not excessive, the sudden drop was assumed to be due to internal hemorrhage. This was apparently confirmed by the continued fall. Pitting edema appeared on November 27, 1938, when the plasma protein was 5.52 Gm. per cent.

Post-mortem examination revealed a massive internal hemorrhage from a bleeding duodenal ulcer.

CASE V. A. J., white, male, age 33, was found in shock following an automobile accident. He was admitted to the hospital in coma.

Traumatic shock, caused by fractures of the femur and the skull, was diagnosed. On admission, the specific gravity of whole blood was only 1.0540, although much higher values were to have been expected. Previous investigators have shown that shock due to factors other than concealed hemorrhage is accompanied by a high specific gravity of whole blood (definitely above 1.0550). In the light of these facts, it was

pointed out that the relatively low specific gravity was indicative of a massive internal hemorrhage. The patient was catheterized with the hope of detecting the source of bleeding and a massive hematuria was discovered. Four hours later the effect of the continued bleeding on the specific gravity of whole blood became even more apparent (1.0437). The aid of the specific gravity determinations made possible the diagnosis of internal hemorrhage even in the presence of coincident shock and coma.

Date	Sp. Gr. of Blood	Sp. Gr. of Plasma	Protein Gm. Per Cent
Dec. 10.....	1.0540	1.0252	6.22
11.....	1.0438		
	1.0437	1.0226	5.34
12.....	1.0439	1.0239	5.78
13.....	1.0475		
15.....	1.0415	1.0241	5.85
18.....	1.0474		
19.....	1.0467	1.0247	6.05

The specific gravity determinations of whole blood can also serve as a valuable aid in differentiating shock due to internal hemorrhage from that produced by other causes.

CASE VI. J. B., white, male, age 42, was admitted to the hospital on November 7, 1938 with a diagnosis of perforated gastric ulcer. An operation was immediately performed and the perforation closed. The blood findings after operation were as follows:

Date	Sp. Gr. of Blood	Sp. Gr. of Plasma	Protein Gm. Per Cent	Edema
Dec. 7.....	1.0582	1.0281	7.21	—
8.....	1.0623	1.0301	7.89	—
9.....	1.0588	1.0277	7.07	—
11.....	1.0520	1.0259	6.46	—
12.....	1.0523	1.0249	6.12	—
17.....	1.0557	1.0256	6.30	—

CASE VII. R. S., white, male, age 22, was admitted with a diagnosis of second and third degree burns of the face and back. The patient had treated himself for one day with vaseline dressings and was markedly dehydrated. The blood findings were as follows:

Date	Sp. Gr. of Blood	Sp. Gr. of Plasma	Protein Gm. Per Cent
Nov. 26.....	1.0629	1.0314	8.34
27.. .....	1.0578	1.0272	6.90
30.....	1.0547		

In Cases VI and VII the specific gravity of whole blood was increased due to dehydration. With the administration of fluids, the dehydration was overcome and the specific gravity of whole blood approached the normal.

#### CONCLUSIONS

1. The Barbour and Hamilton method of determination of blood specific gravity is practical and simple.
2. By daily determinations of the specific gravity of whole blood and blood plasma

preclinical edema can be determined and clinical edema predicted twenty-four to forty-eight hours before it actually appears.

3. The test serves to measure the degree of dehydration.

4. It is of value in differentiating shock from internal hemorrhage, especially in cases of coma, and is a distinct aid in following the course of internal hemorrhage.

We wish to express our thanks to Dr. S. H. Polayes of the Department of Pathology for valuable assistance in the preparation of this report.

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# A NEW TREATMENT FOR SLOUGHING WOUNDS\*

## PRELIMINARY REPORT

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THE need has long been felt for a quick-acting proteolytic agent to facilitate the early healing of wounds. We believe we have found a new chemical method which is successful in the removal of sloughs and suppuration, and which has the additional effect of promoting granulations and epithelization.

In spite of the emphasis recently placed on the ability of living tissue to combat infection, the average method of treatment seems to ignore this fundamental principle. Asepsis and antisepsis alone are not the primary requisites in wound healing. The prevention and elimination of necrosis and debris in wound deserves greater emphasis. Necrosis may be the sequel of trauma, or, more often, the effect of bacterial toxins. That necrotic tissue is a definite handicap to the healing of wounds has been amply proved. Halstead's experiment has served as a classical example: the healthy peritoneum can withstand and overcome enormously large saline suspensions of bacteria, but peritonitis will result from relatively small doses of bacteria if a piece of devitalized muscle or strangulated omentum is present in the peritoneal cavity.

If we consider the wound as a battlefield, the larger necroses can be compared with fortresses, the smaller ones with trenches of the enemy. Unless they are destroyed or eliminated, the battle cannot be carried to the open and the enemy cannot be routed. The body mobilizes its forces by the act of inflammation. By this complex process the invading bacteria are specifically assaulted and, at the same time, necrotic tissue is attacked. In fact, the identical forces act upon bacteria and necroses. In the very early stages of the struggle, the polymor-

phonuclear leucocytes take the lead, their number being proportional to the extent of the tissue damage. These cells not only produce a proteolytic ferment which acts upon the necroses, but actually ingest and devour dead tissue, the whole process being called phagocytosis. Within twenty-four to forty-eight hours the advance guard of blood-borne leucocytes (microphages) receives help from plasma-borne cells (macrophages), which in fact surpass the former as necrosed tissue-eaters. They nibble on the dead tissue at its free margins, forming lacunae similar to the ones produced by osteoclasts on necrotic bone. Passage of the phagocytes into the field is aided by the flushing action of the exudate, which itself helps to loosen and separate the tissues, contributing materially to elimination of dead tissue. The exudate mixed with emigrated cells and dead and liquefied tissue constitutes "pus," the "pus bonum et laudabile."

The labor of these slowly toiling scavengers is substantially supported by the process known as demarcation. Demarcation-separation of dead tissue from healthy living tissue at its borderline is entrusted to the granulation tissue. This is a proliferative change that is moving against the necrosis on all sides, quickly engulfing it and piling up a wall against it. This particular granulation tissue differs from the one destined to fill up a gap. In situations where damaged resistant tissue has to be removed, and where there must in consequence be preliminary softening, cells of a special multinucleated type are brought into the field. Such granulations in the vicinity of dead tissue, sinuses, fistulae, etc., are often exuberant in type and may grow above the

\* From the Surgical Service of Dr. J. H. Fobes, Metropolitan Hospital, New York City.

skin level. This "wild flesh" is flabby, spongy, pale, and does not permit epithelization. Not before the wound is cleansed of all necrotic tissue do the poor granulations change to a healthy, granular, turgescient stage. Following this change, repair of lost substance and epithelization are soon effected and complete healing is surprisingly fast.

The longer it takes to rid the wound of necroses, the more granulation tissue (the progenitor of scar tissue) has to be mobilized, and consequently the more scar tissue is formed. This fact is illustrated best by a comparison of two extremes of wound healing: the minimum of scar in a wound healed by primary intention and the deeply retracted, firm scar resulting from chronic osteomyelitis or tuberculous lesions. If removal of necrosis is a physiologic prerequisite of wound healing in general, its early elimination is evidently desirable for better functional and cosmetic results.

With this exposition of the healing process in mind, we cannot fail to deplore the prevalent indiscriminate use of antiseptics.

We believe that we have an efficient proteolytic compound which (1) does not inhibit normal physiologic cleansing action; (2) stimulates normal cell division; (3) promotes granulations; (4) is by its proteolytic action unfavorable to bacterial growth (not antiseptic); (5) does not attack normal tissues; and (6) is neither toxic nor irritating. All of these properties are present in the constituents of the original formula of the late Dr. Max Baruch. This agent contains two proteolytic ingredients, namely: papain and triethanolamine. The former, an enzyme more stable than pepsin, has long been known for its digestive properties. Papain has been used as a dusting powder and also as a cream paste, but never with any degree of success, the reason being that it loses its potency within four to six hours in an aqueous medium. The difficulty is increased because it is hygroscopic, and therefore easily inactivated. The triethanolamine, although greatly inferior as a proteolytic agent, has two desirable quanti-

ties: first, it acts as a reducing agent, thereby stabilizing and activating the papain which in itself is rendered reversibly inactive by oxidation; second, it serves to moisten and thereby assists in the penetration and impregnation or hydration of protein substances by papain. Triethanolamine emulsions, because of the minuteness of their particles, further augment the therapeutic action of the lytic agents by increasing the surface area of the lytic substances.

The most efficient anhydrous solvents for the papain and triethanolamine were found by experimentation to be oleic and stearic acids and mineral oil in definite proportions in order to avoid sedimentation. Immediately before therapeutic application, water is added in the form of 5 per cent triethanolamine solution. In other words, we keep our reagents in two containers, one called "enzyme mixture" (papain, triethanolamine, oleic acid, stearic acid, mineral oil), and the other designated as "activator" (5 per cent triethanolamine aqueous solution). It is upon the compounding of the papain mixture that we rely for the therapeutic results here recorded.

Papain or caroid (papayotin, vegetable pepsin) is prepared from the juice of the fruit and leaves of carica papaya (papaw). It is an enzyme similar to pepsin but acts in acid, alkaline or neutral solution. It is a white to gray powder and is moderately hygroscopic. It dissolves about 200 times its weight of coagulated egg albumin in alkaline liquid in about five hours. It is very soluble in water and glycerine but almost insoluble in alcohol. It acts only on dead tissue. Harris in 1937 used caroid alone with greatly satisfying results in chronic suppurative otitis media. Tremble concluded that in chronic otitis media, "caroid dissolves thick tenacious mucus" and that "urea and caroid in saturated aqueous solution have a definite action on necrotic tissue. It hastens healing, has a stimulating action and is innocuous to normal tissue. In strong solution it has a slight bactericidal action which is particularly effective on

organisms which produce putrefaction. It practically obliterates all odor—dissolves pus and epithelial debris."

We have employed our method in the following manner: The stable enzyme mixture and the activator are mixed at the time of wound application by thorough stirring until the formed emulsion is of a thick milk-like consistency and appearance. The wound is cleansed with normal saline (peroxide or other oxidizing solutions being contraindicated) and is then covered with the enzyme emulsion or with gauze soaked in the emulsion; or the crevices or tracts may be injected through a cannula. Cellophane or rubber sheeting seals the area to prevent evaporation and oxidation, and to obviate any absorption by overlying dry gauze. The dressing is changed daily or every forty-eight hours depending upon the degree of discharge or necrosis present.

The results obtained in fifty-eight cases have been excellent. Our clinical material is shown in Table I. In no case did the enzyme

mixture fail to remove slough. Coincident with this result, it was noticed that the action of deodorization in foul-smelling wounds was dramatic in effect. Clean granulations appeared early, as would be expected once wound debris had been eliminated. Where enzyme applications were continued after the wounds had cleared up, rapid epithelization was evidenced. The average number of applications required was 2.34. In one case of diabetic gangrene of the foot with a large area of slough and suppuration, seven applications extending over a period of fifteen days were needed to obtain a clean granulating wound. The average time for granulations to form was 6.15 days.

#### DISCUSSION

The healing of wounds depends upon and is inseparably interwoven with the removal of necrotic tissue. Elimination of necrotic tissue is effected chiefly by a process of ingestion and digestion. The amount of scar tissue depends upon the length of time consumed for the removal of necrotic tissue.

#### SUMMARY

1. It is our belief that the new enzyme compound used on our cases is more efficient in removing slough and in promoting the healing of wounds than any other chemical agent in general use.

2. The enzyme mixture was an efficient proteolytic agent in fifty-eight sloughing wounds.

3. Its deodorizing power and epithelium-stimulating effect was marked.

4. Its rapidity of action was outstanding.

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TABLE I

Diagnosis	No. of Cases
Perirectal abscess with slough.....	4
Diabetic gangrene of foot.....	4
Electric burn of thigh—third degree.....	1
Carbuncle of neck.....	3
Carbuncle—dorsum of hand.....	2
Gluteal abscess—diabetic.....	1
Felon.....	2
Inguinal abscess.....	2
Postoperative infection with necrosis—herniorrhaphy.....	1
Postoperative infection with necrosis—umbilical hernia.....	1
Postoperative infection with necrosis—pilonidal cyst.....	1
Old leg ulcers with slough.....	29
Tuberculous inguinal adenitis with slough.....	1
Ulcer of heel—three years' duration.....	1
Sloughing wound of neck.....	1
Abscess of breast.....	1
Indolent wound of foot—six months' duration..	1
Sloughing abdominal wound—after enterostomy	1
Decubitus ulcer over sacrum.....	1



# A MECHANICAL DEVICE FOR THE ADMINISTRATION OF INTRAVENOUS ANESTHETICS

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PENTOTHAL sodium has been found to be a powerful and quick-acting anesthetic agent. Its intravenous use makes it necessary that it be given slowly

or the needle would become occluded by back pressure into its lumen. The same assistant was seldom available for other operations.

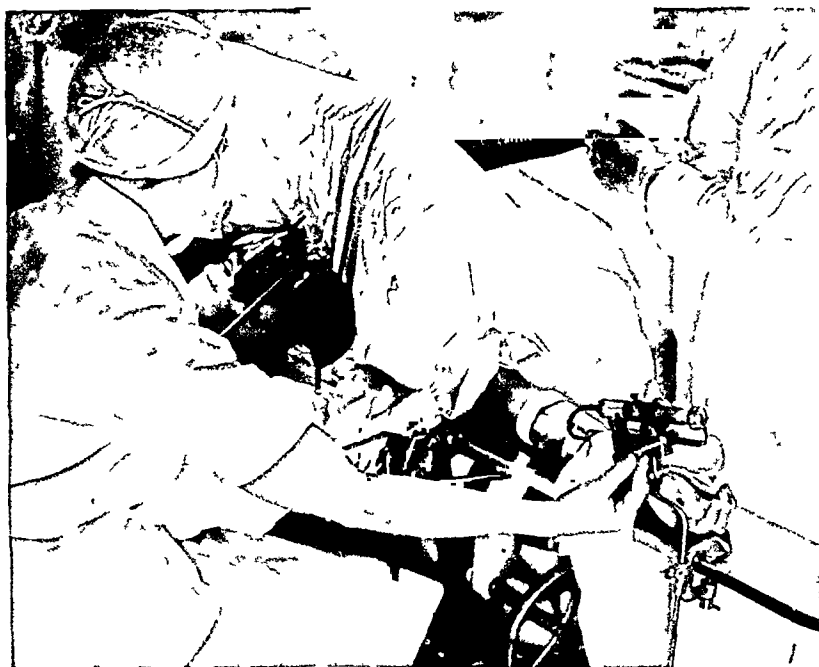


FIG. 1. Illustration shows anesthetist holding up patient's chin with one hand and administering pentothal sodium from syringe by simply turning the gear wheel on the syringe holder.

with only enough for relaxation of the patient, and oxygen should be administered by inhalation throughout the procedure.

Early in our use of this anesthetic agent both an anesthetist and an assistant were needed, one to administer the drug from a syringe, and the other to hold up the patient's chin and administer the oxygen. The problem of giving 20 to 30 c.c. of the solution over an hour's time was perplexing in that invariably either too much of the drug was given to prevent the needle from becoming occluded by a blood clot,

The difficulty that confronted us was the administration of the drug by the anesthetist without the aid of an assistant. One of us (F.F.R.) devised a simple rack and pinion gear attachment for the syringe support that solved the problem. It does away with the help of an assistant; it allows the anesthetist the use of both hands and absolute control over the amount of the drug given, and permits no back-flow into the lumen of the needle, thereby preventing occlusion.

The device as here illustrated (Figs. 1

and 2) shows the syringe held in place by a syringe clamp. The plunger of the syringe is contacted by the movable part of the about the same as the low power on a microscope. During the past eight months approxi-

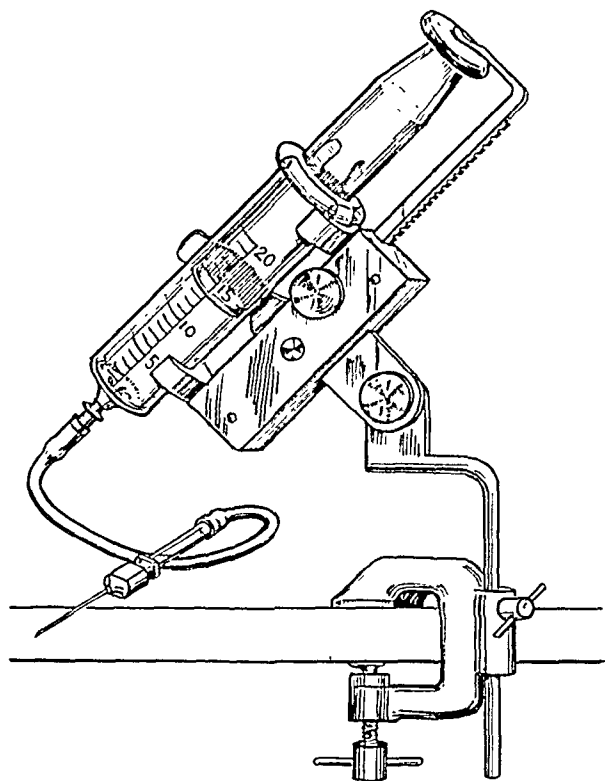


FIG. 2. Drawing shows detailed construction of apparatus.

rack and pinion. The anesthetic solution may be administered as slowly as desired by simply turning the gear wheel with the thumb and index finger, which is geared

mately 1000 anesthetics varying in time from ten minutes to more than two hours have been given with complete satisfaction by this method.



# A SIMPLE METHOD FOR THE COLLECTION OF BILE FROM T TUBES\*

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THE small detail of an apparatus in which to collect bile from draining T tubes is one which is not likely to receive much attention. The patient with a T tube is usually encumbered with a device, such as a small glass bottle or hot water bag, which is poorly adapted to the purpose and is awkward for the patient to wear.

A large, rubber balloon, connected to the T tube by means of a special glass adapter, has been found to be a satisfactory, practical and comfortable apparatus for collecting bile from patients on whom† choledochostomy has been performed. (Figs. 1 and 2.) This two-piece apparatus is light in weight, can be worn comfortably and inconspicuously under clothing, does not permit spilling of bile, provides for direct observation of the bile through the glass connector, and is inexpensive. In addition, contamination of the collected bile can be prevented by simple precautions.

The rubber balloon which is used measures 5 by 6 inches (12.5 by 13 cm.), has a fluid capacity of 300 c.c. without stretching, and is made of white rubber, heavier than that commonly used for toy balloons. The balloon can be boiled or autoclaved many times. The funnel-shaped glass connector is made of pyrex glass. The small end is shaped like an ordinary glass connector and is slightly greater in diameter than the usual T tube. A standard connector diameter has been found satisfactory for all ordinary sizes of T tubes. The large end of the connector is slightly larger in diameter

than the mouth of the balloon. A deep, narrow constriction of this end of the connector serves to hold the reinforced lip of the balloon tightly in place.

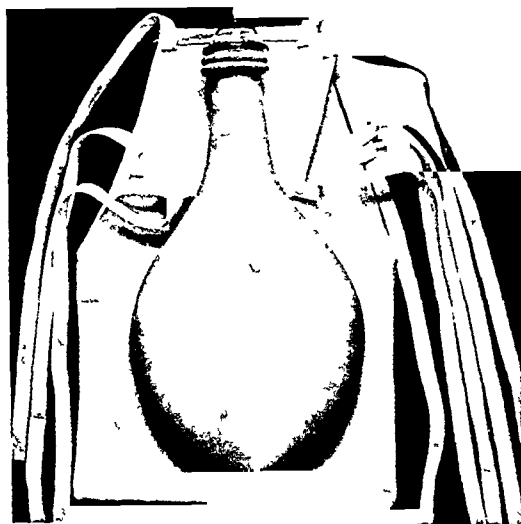


FIG. 1. Apparatus for the collection of bile.

The balloon and glass connector are boiled or autoclaved before being fitted together. We have used sterile gloves and a sterile towel in stretching the balloon mouth over the large end, and the T tube over the small end of the connector. When it is necessary to empty the balloon, the T tube is disconnected from the glass connector, but first, the junction is thoroughly cleansed with 70 per cent alcohol. Inverting the balloon then serves to empty it completely and quickly through the connector. The same apparatus can then be reapplied without contamination of the parts exposed to bile.

† The drainage balloons may be obtained from the Sterling Rubber Company, 176 North Wacker Drive, Chicago Illinois (catalogue #16P).

\* From the Institute of Experimental Medicine, The Mayo Foundation, and from the surgical service of Dr. Waltman Walters.



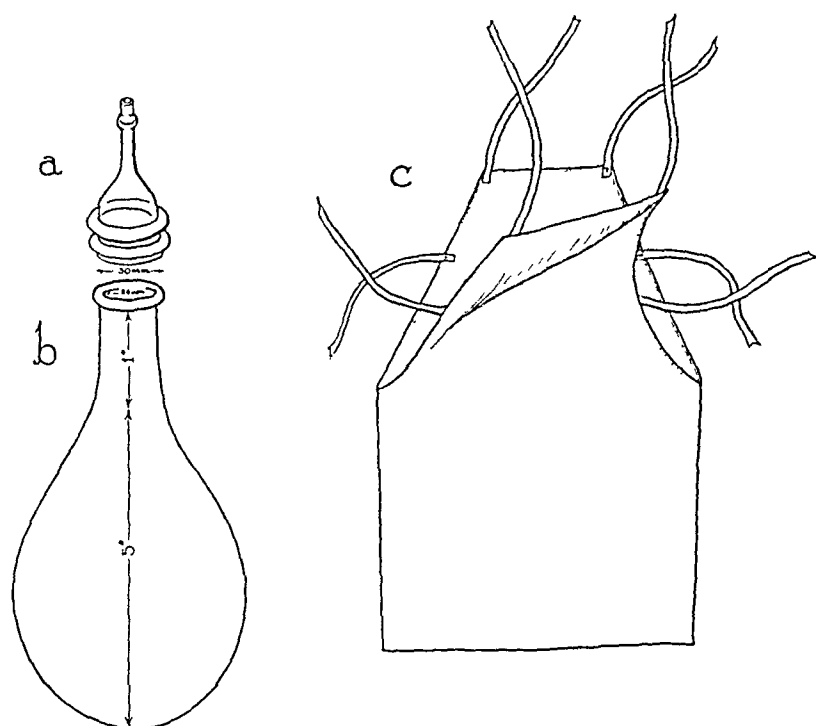


FIG. 2. Details of apparatus: *a*, glass connector; *b*, rubber bottom; *c*, cloth bag.

A washable cloth bag that fits around the balloon is used to contain the apparatus and is supplied with ties that serve the dual purpose of closing the bag and of fastening it to a binder worn by the patient.

Other uses for which the apparatus has been successfully employed are the collection of bile from cholecystostomy tubes and urine from nephrostomy or ureterostomy catheters.



# THE CAUSES FOR FAILURE IN THORACOPLASTY\*†

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THE purpose of this paper is to state certain facts regarding the causes of failure in extrapleural thoracoplasty which have come to our attention in a retrospective analysis of our cases from 1931 to 1939. During the early years of our work it was our custom to do an incomplete, very selective thoracoplasty both as to number and extent of ribs removed over the cavity-bearing area, releasing the apex of the lung as in an apicolysis or extrapleural pneumothorax, and to depend upon extensive gauze packing or inflated rubber balloons to maintain compression. Within the first several weeks the results were good; the sputum became negative and roentgenologically the cavity or cavities were closed. However, removal of the gauze packing or rubber balloon left a large dead space into which the lung reexpanded; the cavity or cavities reopened, the sputum became positive. The final results were failures.

Furthermore, many of these wounds became infected. There was an extensive and intensive parietal pleural reaction, which caused the pleura and the tissues of the chest wall to become thickened, fibrocartilaginous in nature, with frequent calcification. The result was immobilization of the lung in the reexpanded position. Since no further surgical procedures could be carried out in the presence of infection it was necessary to wait weeks and often months for these large infected wounds to clear up, and when second and third stages or the revision thoracoplasty were carried out, practically nothing could be accomplished.

As a result of these experiences, we have given up the use of foreign substances for compression. It is interesting to note, how-

ever, that in two cases in which the gauze packing was accidentally left in the chest wall no ill effects or untoward symptoms have been seen. The sputum has remained negative, and roentgenologically the huge cavities have remained closed.

No doubt it would be a great aid in thoracoplasty if some neutral substance could be left permanently in the chest wall to maintain constant compression, but after our ill-fated experiences with various substances, such as gauze, rubber balloons, crisco, etc., we prefer that some other group carry on with these experiments—we are cured.

Our results also were comparatively poor in cases where an extrapleural thoracoplasty was done in the presence of pneumothorax or pneumothorax with effusion, regardless of the extent of the surgical procedure. The immediate results appeared to be good, but when the pleural effusion or pneumothorax was absorbed the lung reexpanded and the cavity or cavities reopened. Here again the pleural reaction was marked, causing a parietal pleural thickening, and, despite a revision thoracoplasty, very little was accomplished. Consequently no surgical procedure is carried out at present in the presence of pneumothorax or pneumothorax with effusion, until the portion of the lung to be collapsed is fully reexpanded.

We have also concluded that many patients should have been operated upon months or even years earlier than was actually the case, rather than to have been left on bed rest and observation for long periods of time. In some of these cases our surgical results were not good. In these cases unquestionably certain inherent path-

\* Read before the clinical session, Tuberculosis Sanatorium Conference of Metropolitan New York.

† From the Hudson County Tuberculosis Hospital and Sanatorium, Dr. B. S. Pollak, Medical Director.

ologic changes had taken place in the lung, the parietal and pulmonary pleura, and the chest wall itself, which precluded any effective collapse.

In still other cases, phrenectomy was performed. This did not close the cavity and valuable time was lost before thoracoplasty was done.

It was found also in cases where ineffectual pneumothorax had been carried out for a long period of time, that the parietal pleura had become thickened and there was immobility of the chest wall to a varying degree. The results of extrapleural thoracoplasty in these cases were not so good as in cases where ineffectual pneumothorax had been carried out only for a short period of months, or in cases in which pneumothorax had not been done at all.

We feel now that cases should be observed for a comparatively short period of time. Long periods of observation and of ineffectual pneumothorax, especially in cases of adherent, peripheral apical cavities, are inadvisable. These patients should come to surgery sooner.

In our surgery *per se* we are of the opinion that we have been too conservative—that we have been too limited and too selective in our surgical procedure both as to the number of and extent of ribs removed. In our procedures the apex of the lung was freed as in the Semb's operation; this caused a vertical drop and a vertical collapse of the cavity. This also, very often, caused the cavity to drop an interspace or more without actually collapsing the cavity—it merely changed its shape. Nor were we very thorough in the juxtavertebral resection of the ribs or the transverse processes which should aid in the obliteration of the cavities throughout the greater diminution of the transverse diameter of the cavity.

Our tendency was to delay too long between stages, hoping that thoracic contraction would occur and thus obliterate cavities. This, however, did not occur in a large majority of cases. Owing to this delay, in many cases the ribs regenerated, the pleura

and the tissues of the chest wall became fibrocartilaginous, while in others calcification occurred. Therefore when the next stage operation or a revision thoracoplasty was done, the patient was subjected to a difficult, bloody, shocking procedure. A complete, effectual, extrapleural thoracoplasty with a maximum delay of four weeks between stages would have accomplished our aim in a majority of the cases.

As a result of our too limited and too selective thoracoplasties some of the cases that at present show negative sputum and roentgenologically closed cavities, are likely at some future date to show a positive sputum with reopening of the cavities. Some will develop, as they have in the past, a contralateral spread.

Although the amount of collapse which will follow any operative procedure is unknown, we do know that some cases will show a much greater degree of thoracic contraction after thoracoplasty than others. Nevertheless our feeling is that we should be more radical with respect to number and extent of ribs to be removed, with especial effort to eliminate the paravertebral gutter and to shorten the interval between stages.

It is difficult to compare statistically the results of different clinics, because of the wide variations in the interpretations of operative indications. Despite all our shortcomings, 58 per cent of our cases after three to five years have absolute cavity closure by Roentgen determination, and negative sputum. The immediate postoperative results showed a much higher percentage of closure.

#### CONCLUSIONS

Pulmonary tuberculosis is neither a medical nor a surgical disease, but rather one in which all specialties may add something to the patient's chances of recovery. The results of thoracoplasty depend not only upon the surgeon (granting that an effectual, complete, selective type of extrapleural thoracoplasty is performed), but upon the coöperation of other specialists.

## A NEW AND EFFECTIVE ANORECTAL DRESSING\*

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**F**OLLOWING anorectal operations bacteria-laden moisture continuously bathes the operative field. This irritating excretion promotes profuse granulation, retards epithelization, induces painful wounds, creates a sense of uncleanness, excites pruritus ani, slows the process of healing, and leads to the development of a tough, deforming and sensitive scar. Post-operative dressing with an ointment or powder markedly increases this moisture.

It occurred to us to seek an analgesic, astringent, germicidal and mucilaginous dressing. The latter property causes prolonged contact with the tissues. Following experimentation with many agents, we selected a mixture of 3 per cent gentian violet, 10 per cent tannic acid and 1 per cent pontocaine in a heavy mucilage of acacia.

To prevent the formation of crystals and small lumps, this mixture must be painstakingly compounded. A thick and smooth mucilage is essential. The following plan for preparation of 500 c.c. of the mixture is recommended: Dissolve 5 Gm. (50 tablets, each gr.  $1\frac{1}{2}$ ) of pontocaine in 4 ounces of distilled water. Add 50 Gm. of tannic acid and stir until dissolved. Add 15 Gm. of gentian violet crystals and stir until a solution is effected. Strain through gauze into a large mortar. Add slowly, while agitating vigorously, sufficient acacia to make a thick paste. This requires approximately 250 Gm. of acacia. Now add gradually, stirring continuously, distilled water to make 500 c.c. Let the mixture stand in mortar twenty-four hours, stirring every three or four hours if possible. At the end of this time agitate vigorously with pestle, then force the thick mucilage through two layers of gauze with

the aid of a spatula. This mixture remains stable when kept tightly corked.

During the first thirty-six hours following completion of the dressing, a light foam may form on its surface, precipitating a thin layer of acacia. The acacia will return into solution if stirred. To facilitate its application on the gloved finger or on an applicator this dressing should be dispensed in a wide-mouthed container. A properly made mixture spreads on the skin as a smooth and homogeneous mucilage, drying quickly to remain as a purple paint.

When an operation is concluded, we apply the dressing generously to all wounds: circumanal, anal and rectal. Subsequently the operative field is dried after each sitz-bath and an attendant then applies the dressing to the circumanal wounds. During the first postoperative week the dressing is applied twice daily to the wounds within the anal canal and rectum by means of a small, soft, mop-like applicator. Thereafter, its application within the canal is made once daily by us and to the circumanal wounds by the patient or an attendant after each sitz-bath.

We have employed this dressing routinely and with uniform results since January, 1938. Its proved advantages are: (1) absence of postoperative oozing; (2) marked control of postoperative hyperesthesia, pain, edema and pruritus ani; (3) a mild tanning of the tissues with continuous dryness of the field; (4) absence of exuberant granulation. This tissue remains firm and level with the skin, presenting a healthy pink appearance without a tendency to bleed, and (5) rapid healing with resultant thin and flexible scars.

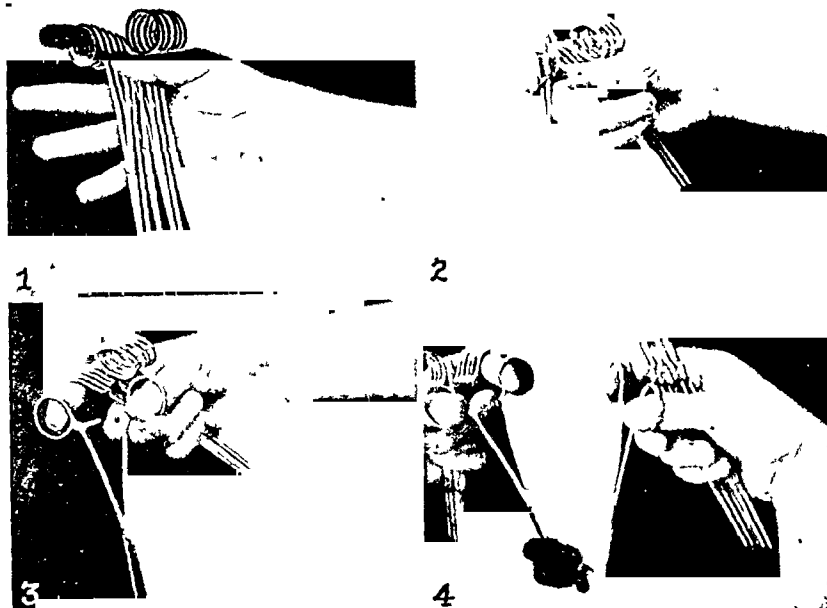
\* Read before American Proctologic Society, Brooklyn, New York, June 25-27, 1939.

# A METHOD OF HOLDING MULTIPLE ARTERY CLAMPS

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**A**N artery clamp can be held like a scissors or between the thumb and forefinger like a thumb forceps. main free for retracting or sponging. Or the sponge can be held with the clamp in the other hand. (Fig. 4.) When a clamp is



FIGS. 1 TO 4. 1, The clamps are picked up on the index finger. 2, As a clamp is needed, it is pushed forward and grasped between the thumb and second finger. 3, Clamp unlocked and poised for grasping a bleeder. 4, The assistant may hold clamps in both hands.

(Fig. 3.) Holding it the latter way, one has better hand to point coördination for this is the natural manner in which one holds other small hand tools such as a pencil, pen, brush and scalpel. All parts of the wound can be reached without twisting the upper arm or body. Either hand can be used with dexterity. It is also much the handier method if the team works sitting down. The clamps can be passed one at a time, or if one is working without an instrument nurse, six clamps can be taken up in a bunch.

Pick up the clamps by passing finger one through the upper ring. (Fig. 1.) Hold the shafts close in the palm with fingers three and four. The tips of the other fingers re-

needed, flex fingers two, three and four behind the next clamp. Grasp this clamp firmly between fingers one and two (Fig. 2) and push it forward. Then flex these two fingers and bring the ring of the clamp over the end of the thumb. Grip the thumb ring tightly between the thumb and finger two. (Fig. 3.) Unlock the instrument by slightly apposing the thumb and index finger. The open clamp is now held poised for grasping, gripped only by the thumb and finger two. The index finger does not grip but opens and closes the jaws and locks them after the vessel has been grasped.

When the clamps are picked up for tying off, they can be held in this same manner and unlocked and removed.

# CASE REPORTS

## THECOMA OF THE OVARY

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THE origin of tumors of the granulosa and theca cells of the ovary is still a matter of debate. It is not even certain that these tumors are two distinct entities. For that reason, it seems wise to publish any cases that may serve to clear up the problem.

The case under discussion was a fibromatous tumor of the right ovary. The tumor extract contained a substance whose reaction was similar biologically to estrogen, that is, it caused an enlargement of the uterus in the mouse test.

The patient was an unmarried woman of 36 whose menstrual flow had always been regular. Following intercourse, there was no menstrual period for six weeks. Then there was slight bleeding, followed by scant bleeding at irregular intervals for six to eight weeks. At the same time the patient became aware of an enlargement of the uterus. Believing that she had become pregnant and that an incipient abortion was in progress, she consulted the writer.

The uterus was enlarged to the size of a four months' pregnancy; however, it was not so soft as a pregnant uterus and Hegar's sign was not marked. The right ovary was enlarged to the size of a fist. The Aschheim-Zondek test was done and returned as negative. Accordingly, a diagnosis of granulosa cell tumor was made, and the neoplasm removed by laparotomy.

Macroscopically, the tumor resembled a fibroma with distinct lighter nodules varying in size from that of a pinhead to that of a cherry and elevated from the surface. Microscopically, the picture was that of a fibroma with strands of connective tissue interlacing. In the interstices, however, were masses of

oval and polygonal cells whose nuclei stained deeply and whose protoplasm showed vacuoles and, under fat stains, proved to be lipoids.

### DISCUSSION

The Wilson Laboratories prepared an extract of the tumor to ascertain its endocrine properties. The extract was injected subcutaneously into infantile mice in equal quantities for four successive days. At the same time infantile mice were treated with theelin and anterior pituitary hormone. Mice of the same litter were kept as controls under identical conditions. The uteri of the animals treated with the tumor extract, as well as those treated with theelin, showed a distinct enlargement as compared with the controls; there was no reaction on the ovary. The reaction was, therefore, that of estrogen and this estrogen was obtained from a fibromatous tumor. It may well be assumed that the estrogen did not come from the connective tissue but rather from the vacuolized cells. Nothing seems to speak for the assumption that the hormone was formed outside the tumor and only stored up in it, because the patient had at no time been pregnant.

The ability to produce female sex hormone is common to a granulosa cell tumor and to the tumor under discussion, which may be tentatively classed as a thecoma. Both produce estrogen and cause glandular cystic hyperplasia of the endometrium. However, macroscopically the granulosa cell tumors are soft formations surrounded by capsules of connective tissue. They can acquire considerable size (the tumor herein

described weighed 7 pounds); the interior contains a spongelike substance which, as the tumor increases, inclines to disintegrate

losa cell tumors contain a preponderance of simple breaking lipoids, whereas the lutein cells of the theca tumors show a preponder-

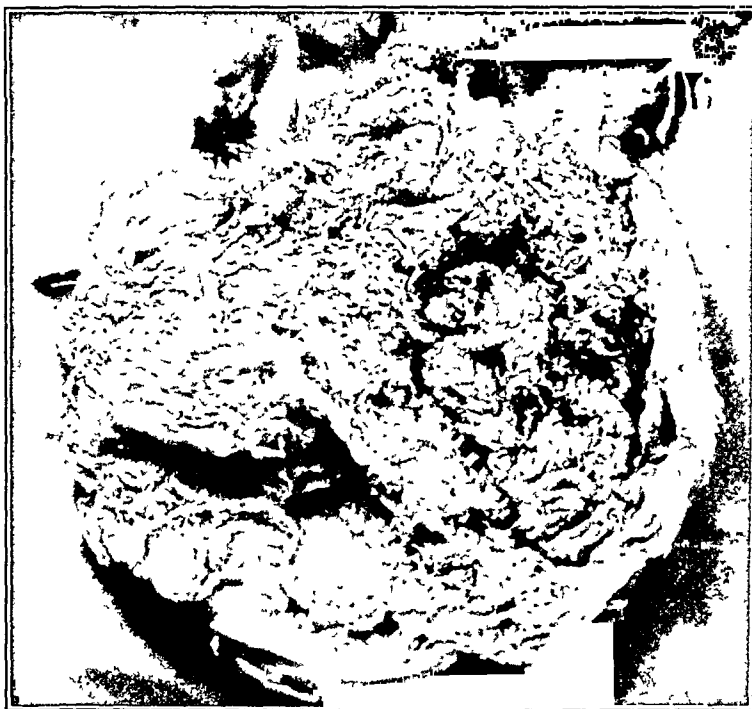


FIG. 1. Cross section of granulosa cell tumor. (*Am. J. Obst. & Gynec.*, 36: 688-693, 1938.)

to form cavities that contain a blood-tinged fluid. Theca cell tumors are hard and show a preponderance of connective tissue in which the tumor cells proper are arranged in groups. Microscopically both tumors are composed of connective tissue and tumor cells. In granulosa cell tumors the tumor cells predominate, whereas in the thecomas the tumor cells are much fewer. It would seem that the granulosa and theca cells have the power to multiply and grow at the expense of the connective tissue. In the case of granulosa cell tumors the cells not only multiply, but the tumors show progress from trabecular to solid and follicular form.

The granulosa cells differ from the theca cells in various properties; the former have weakly defined cell outlines, their nuclei stain well, are of good size and are round or oval, and it is very seldom that any lipoid substance is found in these cells.

According to Motta, the cells of the corpus luteum and of the luteinized granu-

ance of double breaking lipoids; however, these cells lose their double breaking property when they are slightly warmed. The presence of lipoid substance in both kinds of cells is evidence that in some respects these tumors are related. These reasons, together with the morphologic ones, argue for a common origin of granulosa cell and theca cells from the mesenchyme of the coeloma, as Fischel and Schiller maintain, but the stimulus transforming the mesenchyme cells to granulosa cells is apparently different from the one which calls forth the formation of theca cells.

According to Hertwig-Waldeyer, the parenchymal cells of the ovary develop by ingrowth of the gonadal surface epithelium into the underlying embryonic connective tissue. From this point of view we should have to assume that such highly differentiated cells as ova and spermatozoa could develop out of mesoderm cells which originally cannot be distinguished from the cells

which supply the endothelium of the peritoneum. This appears unlikely, as does the opinion that the sex cells originate in the epithelioid elements of the germ gland at a later stage of the development.

After the work of Nussbaum, Galton, Boveri and Beard, Weissman's theory is justified, that the sexual cells follow a course of development which differs altogether from that of the other somatic cells. They apparently retain their totipotent quality, which is essential to the first offshoots of the fertilized ovum. The sexual cells differ at an early stage from other embryo cells by reason of the chromatic elements of the nucleus. Their progress can be followed through the earliest segmentation cells along a definite course. In mammals they take their way into the primitive streak, then into the dorsal wall of the intestine; then they wander through the connective tissue of the mesenterium toward that spot on the dorsal wall of the body where the germ gland arises. So primi-

The difficulties in explaining the histology of granulosa and theca cell tumors are easier to understand if we accept Fischel's

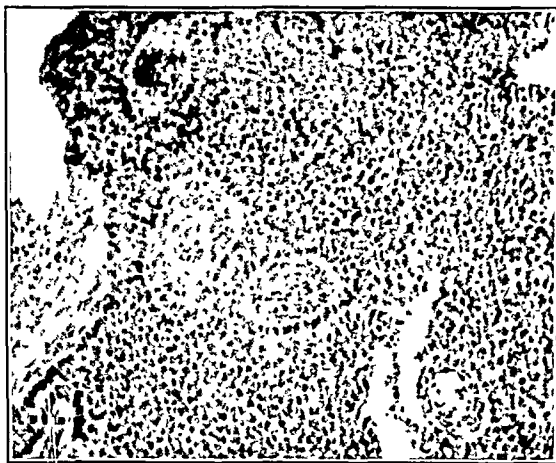


FIG. 2. Granulosa cell tumor, solid mass and follicle formation. (*Am. J. Obst. & Gynec.*, 36: 688-693, 1938.)

view that the granulosa cell originates in the mesenchyme through differentiation called forth by the formative stimulus of



FIG. 3. Granulosa cell tumor, trabecula formation. (*Am. J. Obst. & Gynec.*, 36: 688-693.)

tive sexual cells (archygonocytes) seem to be the mother cells of sperm cell and ovum. The latter are not derivatives of the germ epithelium nor the product of the sex glands, but direct derivatives of the fertilized ovum.

the primitive sexual cells (archygonocytes), after the latter have made their distant migration to the spot. And the theca cells are apparently cortex cells of the ovary modified by the ripening process of the



Graafian follicle. "They are not a part of the follicle, take no part in formation of the corpus albicans" (Gardner).

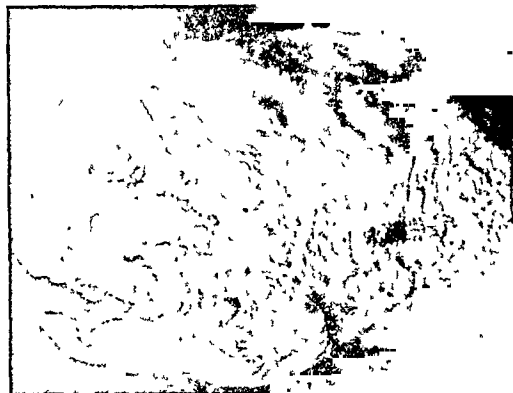


FIG. 4. Thecoma: fibroma with nodules of theca cells.

These cells seem to be analogous to the decidua cells of the endometrium (decidua menstrualis and graviditatis). In the atretic cysts there is no intermingling of granulosa and theca cells. The theca cells are apparently the result of a softening process of the cortex to facilitate the rupture of the follicles.

Tumors of desmoid nature containing lipid were first differentiated by Loeffler and Priesel who called them "fibroma thecacellulare xanthomatodes ovarii." These tumors have been separated from the granulosa cell tumors in the opinion of some investigators, while others oppose their segregation because granulosa cell tumors and thecomas have a common origin from the embryonic ovarian mesenchyma. This is true and is in accordance with Fischel's view that the mesenchymal core of the plica genitalis undergoes its transformation under the influence of the primitive ovum (archyonocyte); the archyonocyte causes the development of granulosa cells and the ripening of the ovum transforms the adjacent connective tissue into theca cells similar to the transformation of connective tissue cells in the uterus into decidua.

#### SUMMARY AND CONCLUSIONS

1. An ovarian tumor is reported which macroscopically and microscopically is clas-

sified as thecoma, a fibroid tumor containing nodules of theca cells of different size.

2. The tumor produced estrogen.

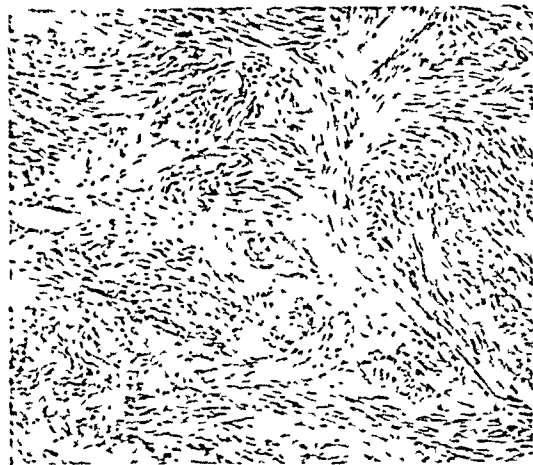


FIG. 5. Thecoma: low power magnification.

3. It caused a glandular cystic hyperplasia of the endometrium, enlargement of the uterus and irregular metrorrhagias.



FIG. 6. Thecoma: high power magnification.

4. In spite of similarities in granulosa cell and theca cell tumors, i.e., estrogen production and lipid contents, there are differences macroscopically and microscopically.

5. A segregation of granulosa cell tumors and thecomas seems to be justified.

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TUMOURS form occasionally in the root of the mesentery and behind it, constituting the retroperitoneal lipoma or sarcoma. . . . It is seldom that a retroperitoneal sarcoma can be enucleated, and treatment by irradiation must be employed.

# RARE MALFORMATION OF THE ARM\*

## DOUBLE HUMERUS WITH THREE HANDS AND SIXTEEN FINGERS

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ALTHOUGH the literature of the past 150 years abounds with case reports of supernumerary members, we have been unable to locate any report of an aberration such as is here presented. In this case a woman of 52 had gone through life with a normal left arm, but a right arm double average size and terminating in three hands of more or less normal appearance.

Paré reports an almost legendary monster born with four legs of equal proportions and two supernumerary arms the day peace was made between the Venetians and the Genoese. Haller<sup>1</sup> reported several instances of supernumerary extremities in 1758, and Saviard<sup>1</sup> saw an infant in 1867 which had ten toes on each foot and ten fingers on each hand. A patient cited by Murray<sup>2</sup> came closer to the type of anomaly seen in our case: She had an abnormal left arm with imperfect flexion of the elbow, which terminated in a double hand with rudimentary thumbs and webbing of the middle and ring fingers.

Bradford and Lovett<sup>3</sup> saw a patient with fifteen fingers and thirteen toes. Joachimstal<sup>4</sup> and Klaussner<sup>5</sup> also reported similar disturbances. The latter in 1900 described double humeri. The most recent monographs which deal with deformities of the upper extremity are those of Mueller<sup>6</sup> and Gruber.<sup>7</sup> Apparently none of these authors had observed an anomaly so bizarre as occurred in the present case.

### CASE REPORT

E. G., an unmarried woman of 52, accidentally came under our observation. She had as her sole deformity an amazing right arm, double the size of the left. The lower portion

of this arm was imperfectly separated into two parts by a shallow skin fold which ended at the elbow. The forearm terminated in three hands, a proximal, a distal and a middle, which we may call hands A, B, and C. In addition there was what might be considered a rudimentary fourth hand which consisted of supernumerary fingers and a large carpal bone. (Figs. 1 and 2.)

The proximal (upper, cranial or anterior) hand, A, was kept in maximal pronation. The lower, distal, caudal or posterior hand, B, was kept in maximal supination. The middle or lateral hand, C, was maintained in a position of hyperpronation. C was attached to A by a web formation at the ulnar side, in the center of which the two rudimentary finger stumps could be seen. C was likewise attached to B by a common thumb which served them both. The carpal bases of all three hands were inserted in a kind of funnel arrangement, so that each hand was in a separate plane, rotated 90 degrees from the others.

The three hands could perform useful tasks alone or in combination, since they had muscle groups of normal shape and number. The radial artery could be palpated at all three radial areas. The hands could be flexed and extended independently, making all possible combinations of flexion and extension possible. However, for obvious reasons, the patient had found it advisable to cover two of the hands with a scarf arrangement, using only one, B, the lower hand for her work. For twenty-five years she had filled a position as telephone operator and file clerk, apparently without major inconvenience. She relied chiefly on her left hand, using the B hand on the right side for such activities as a left-handed person might.

The family history, so far as the patient or her 83 year old father could remember, was completely negative. The patient's own growth and development had been in all other respects normal. Whether as a result of the deformity or by normal temperamental inclination, the pa-

\* Presented at the New York Academy of Medicine at the joint meeting of the New York and Philadelphia Orthopedic Sections.

tient was shy, secretive and introverted. She tried to evade any inquiry about or examination of her arm and resisted any offers to attempt its correction.

fourth cervical vertebra at a sharp angle. The spina scapulae could not be palpated. The cervicodorsal spine showed marked curvature to the right.

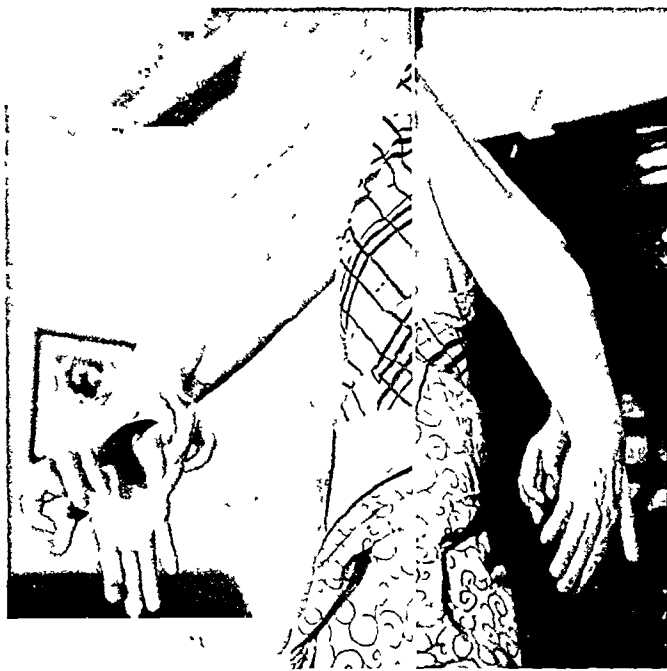


FIG. 1.

FIG. 2.

FIG. 1. Anterior view with forearm in supination. Note common thumb for distal and middle hands; also rudimentary finger in web between middle and proximal hands.

FIG. 2. Posterior view—proximal and distal hands visible.

The abnormality, present of course from birth, had never troubled her. The abnormal size of the arm and shoulder had induced her to have a shoulder brace made when she was 25 years old. This was intended to keep the shoulder blade back; but since it caused more discomfort than the disability it was designed to help, it was soon discarded.

**Examination.** The arm was maintained in 20 degree abduction, but could be abducted to 45 degrees at the shoulder. Adduction of 20 degrees, flexion, forward and backward rotation and retroversion of 50 degrees were also possible. Outward rotation (with the arm to the side) was the full range of normal, but inward rotation stopped at two-thirds of the normal range.

The combined elbow showed a flexion contracture of 20 degrees, could be flexed to 45 degrees, supinated normally, but pronated only halfway. The shoulder blade was 9 inches long and 9 inches across (as compared with 6 by 5 inches for the left shoulder). It joined the

The acromion on the right side was 3 inches higher than on the left, due to a giant scapula. The sterno-acromial line was anteverted and uplifted (5.2 inches long at the right side and 6.2 inches at the left).

Hand A (proximal) was kept in 10 degrees dorsiflexion, its distal phalanges flexed at an angle of 10 degrees, with the thumb in 45 degree adduction under the middle hand. Each finger could be moved separately in extension and flexion. A fist could be made and the patient could hold a fountain pen with this hand. However, the thumb, due to a flexion-adduction contracture, had little power of abduction, adduction and opposition.

Hand B (posterior or caudal) was the most normal in appearance of the three, and it was this one which the patient was accustomed to keep uncovered for use. Its thumb, however, was common also to hand C, which formed the lateral plane of the hand triangle. This thumb had full power of adduction and opposition.

In hand C a flexion contracture of the middle phalanges of the third, fourth and fifth fingers was noted. The range of motion of the three hands is indicated in Table 1.

scapula. The scapula extended from the seventh rib (its mesial border 2½ inches from the right transverse dorsal processes); the upper end converged up towards the fifth cervical verte-



FIG. 3. Note single clavicle; double scapula articulation in a giant scapula; double humeri.

*Roentgenographic Examination.* X-rays revealed two humeri of normal length and shape.

TABLE 1

	Hand A Degrees	Hand B Degrees	Hand C Degrees
Wrist flexion.....	10	10	20
Wrist extension.....	10	10	10
Abduction.....	partial	20	10
Adduction.....	partial	20	10
Basal phalanges (flexion)....	70	80	90
Middle phalanges (flexion)...	30	45	10
Distal phalanges (flexion)....	10	10	10
Interossei.....	normal	normal	normal

(Figs. 3 and 4.) Both humeral heads articulated in separate shallow glenoid fossae of a giant

bra. The latter showed evidence of spina bifida.

The clavicle, originating at the level of the middle of the fourth rib, led to a bulky acromion near the outer humerus. No second clavicle was visible, but a large coracoid process, 6 inches long, could be seen at the mesial side of the inner humeral head, reaching half an inch below the inner side of the surgical neck. At the articulation of the inner humerus, a shallow acetabulum articulated only halfway with the mesial part of the inner humeral head. No acromion was seen. An irregular jagged border led to the second, outer, humeral articulation, with no formal glenoid. Only one acromioclavicular joint could be distinguished with markedly enlarged acromion embracing the humeral head laterally. Three sharply defined

bony edges led to the upper lateral scapula angle. The scapula was markedly shifted to the lateral chest wall, only one-eighth of its width

articulated with an incomplete carpal row of hand *B*. Lateral to the radius a single ulna was attached to the lateral condyle of the medial

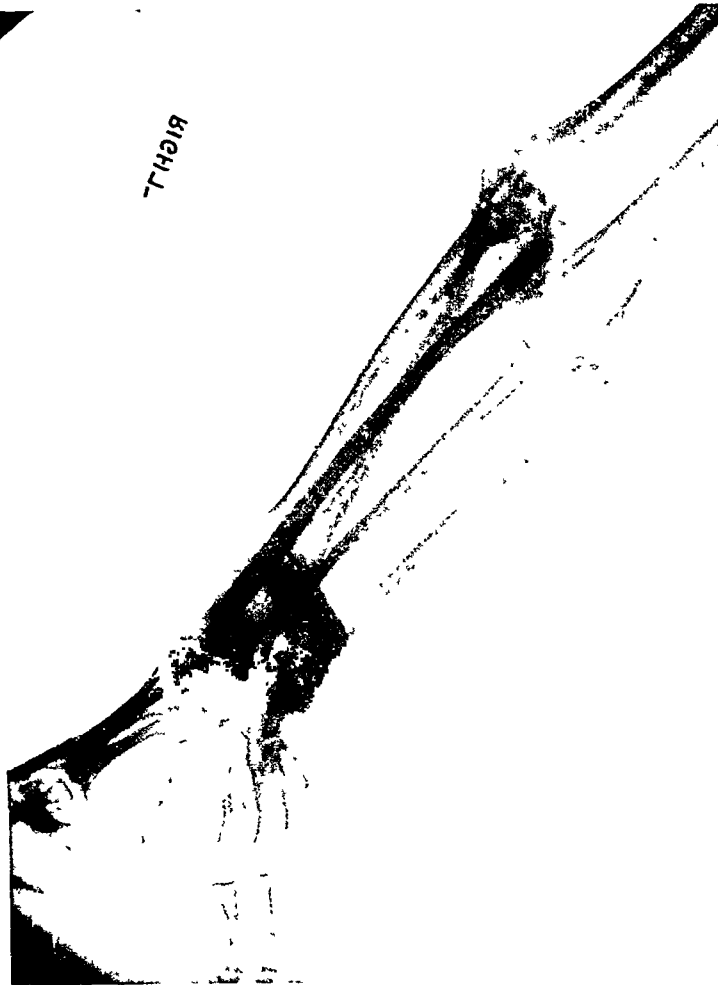


FIG. 4. Showing relationship of the forearm bones at the elbows and wrists.

being in contact with the ribs. It was very much rotated outward.

The humeri showed extremely flat trochleae which articulated incompletely and irregularly with the semilunar notches of the ulnae. The ulna for hand *A* was proximally and medially displaced. The radial head was opposite the inner humerus and showed marked flattening. (Fig. 5.) Two radii and three ulnae were present in all. The inner radius was normal in appearance and articulated with a shallow trochlea of the inner humerus. Corresponding to it was a medial ulna in only partial articulation with the medial condyle. The coronoid process and the olecranon were not in contact with the coronoid and olecranon fossa, these being absent, but

humerus. Between the two ends of the humeri, without joint contact, the olecranon and coronoid processes were markedly elongated, the distal end articulating with the proximal carpal row of hand *C*. The radius corresponding to this ulna was missing. (Fig. 7.) The third ulna articulated normally with the lateral humerus. However, the medial condyle was also enlarged and elongated. The proximal end of the ulna was covered by an elongated radius without capitellum formation. It was only loosely attached to the lateral epicondyle. This radius and ulna articulated with hand *A*. The coronoid process, however, apparently pointed backward, while the olecranon articulated in front of the humerus. This whole humeroulnar mech-

anism apparently had rotated 180 degrees. The dimensions of these parts are detailed in Table II.

phalanges flexed. The lower hand, *B*, was complete in respect to carpal bones and its phalanges were entirely normal. The thumb, as



FIG. 5. Note the common thumb and navicula bone for the terminal and middle hands.

The hands themselves made an interesting x-ray picture. The upper, cranial hand, *A*, showed incompleteness in the form and number of the carpal bones, but had phalanges grace-

fully slender and normally shaped. This hand was maintained in an 80 degree dorsiflexion, complete pronation, with the middle and distal

previously noted, served hands *B* and *C* in common. Hand *B* was in complete supination. *A* and *B* had both radius and ulna, while *C*, kept in midpronation and supination, had only an ulna, maintaining connection with the radius of *B* through the radius, common scaphoid and trapezium. The carpal bones of *C* were normal.

Between the ulnar sides of the upper and lateral hands a web formation was noted. This ended at the level of the middle and distal phalanges. It contained in its distal border two stumps with bony spurs simulating distal phalanges of rudimentary fingers. At the level of the distal carpal row a solitary bone about 1.5 inches wide might be considered as an os centrale.

TABLE II

Humeri...	Length 10.7 inches
	Separation from each other 1.5 inches
Diaphysis .	Outer humerus 0.5 inches
	Inner humerus 0.75 inches
Humeral head .	Outer humerus 1.5 inches
	Inner humerus 1.25 inches
Scapula..	Medial length 9 inches (left was 4.5 inches)
	Upper border 2½ inches above 1st rib—6.5 inches
	Outer border 6.5 inches (left was 5.5 inches)

It articulated with a radius and ulna about 4 inches shorter than normal and had an incompletely developed carpal bone complex. The lower hand, B, most normal of the three, was volarflexed and supinated about 180 degrees against the opposite hand. It had a thumb in common with the lateral hand, C. The lateral hand was in 90 degree rotation opposite the other two and held midway between supination and prosupination.

#### DISCUSSION

**Causes.** In searching for the origin of an abnormality such as the one here described, one must consider the possibility of endogenous or exogenous causes. The fact that the patient manifested no other abnormalities or defects and that none have been discovered in her family, apparently excludes an endogenous (hereditary) factor. Some type of damage originating from without during gestation is a more probable cause.

Various theories may give a greater or lesser approximation to the probable chain of events. Aschner-Engelmann<sup>8</sup> propound a gene or gene-complex which governs normal development; a pathologic opposing factor could, in their opinion, produce abnormal or supernumerary formations by affecting this gene. Non-specific injuries (pressure, temperature, chemical changes, etc.), by provoking diminished resistance of the genes, could thus possibly lead to abnormal development.

Dubrüner<sup>9</sup> points out that though the insult may be non-specific, the reaction of the cell is quite specific. The extent of variations produced would depend upon the development already achieved. The less differentiated the cell, the wider the variety possible. Greater progress in differentiation produces more resistance to a change in form.

Przibram<sup>10</sup> shows that disturbances of any nature may produce changes in *rate* of growth as well as in form. Trauma increases rapidity of growth until the injured part has once more caught up.

In our opinion, we can apply the Arndt-Schultz law to explain the occurrence of

deformities, somewhat in the following manner: (1) minor stimuli cause irritation and result in overgrowth or division; (2) major stimuli cause inhibition and result in stunting, absence of division, webbing, etc., and, if exceptionally severe, will result in necrosis or loss of body parts.

According to the theory of Murk Jansen,<sup>11</sup> the degree of harm done depends on the rate of growth. Fast growing cells are especially vulnerable and may be affected by amniotic pressure. Excessive pressure may lead to ischemia, lack of nutrition and resultant growth disturbances.

To put all these theories together, we arrive at the following "explanation" for the abnormal development in the present case: Non-specific irritation may have occurred at a period of gestation when the right shoulder and arm were being formed but were not yet completely differentiated. Possibly an excessive amount of building material was present, and when the rate of growth was accelerated to make up for the harm done, a double humerus and plural hand resulted.

Some form of injury is thus the most probable explanation. What the irritating mechanism was we have no way of knowing, although the following may be considered:

1. Intra-abdominal pressure in pregnancy may have been abnormally increased, causing adhesions between the amnion and an extremity of the embryo. If expansion of the fetus and of the amnion did not take place in the same proportions, the points of adhesion might lead to superficial or deep grooves, and these might eventually become completely separated. In the case under discussion, grooves of separation appear down the arm, while the hands are separated completely.

2. Diseases of the amnion or of the uterine mucosa may adversely affect the embryo.<sup>10</sup> The fetus is well protected against injury, but inflammation or other disturbance of the maternal genital tract may have been present before conception. Insufficiency of amniotic fluid and excessive amniotic fluid have both been suggested as



causes of deformity. Doederlein suggests also that hemorrhage into the fetal membranes may be a factor. Usually, it is believed, the mechanism in these changes is pressure ischemia.

3. Physical or mental trauma, infectious and toxic influences, maternal genital pathology, etc., must also be considered. In certain cases, x-rays, particularly if applied in early pregnancy, have produced monsters. This may be excluded in our case.

4. Various experimenters have produced sports in animals by altering their milieu (or their bodily form). Loeb found that double monsters resulted from chemical changes in seawater; Hertwig produced spina bifida and other changes by alterations in temperature; Bodenstein caused duplication and reduplication of legs by interchanging the right and left legs in the embryos of butterflies or by turning the legs 90 degrees. Schade<sup>12</sup> produced deformities by calcium deficiency and changes in sodium chloride metabolism. Experimental fracture of an extremity in some cases resulted in duplication.

Whatever pathogenetic factor is postulated, in our case the spina bifida of the fifth cervical vertebra was presumably the result of an insufficient vertebral segment or a secondary injury to the area of the somites.

*Time of Injury.* It is interesting to speculate at what time the causative injury took place. Our conclusion is that it must have been very early in embryonic life, probably in the third or fourth week. At this time, two pairs of small, bud-like prominences or round tuberosities appear anteriorly at the sides of the embryo, representing the blastomatous arm mesenchyme. They later acquire a sort of mitten formation, without finger differentiation. The scapula is very high, at the level of the four lower cervical vertebral bodies. Injury or arrest of development at this stage would cause deformity of the whole scapula-arm-hand complex, since this period is one of rapid change and differentiation for the upper extremity. The diminished resistance

of the extremity would make it unusually responsive to any noxa.

During the separation of the skeletogenous material, some factor produced segmentation, causing two humeri, two radii and three ulnae to materialize. A rotation produced an opposition of the third hand to the two others. The scapula probably separated originally and then fused into one giant scapula while the humerus, lower arm, and hand split in three different planes. As Klaussner pointed out, in duplication of the hand, the radial margins face each other with one thumb or none at all in the middle axis and suppression of the radial segment (note the missing radius of the lower hand). The upper hand shows so-called ulnar adaptation in a different plane.

Fracture of the scapula-arm-hand blastema in the third or fourth week may have caused a process of degeneration, followed perhaps by a process of super-regeneration with rearrangement of the skeleton. Perhaps as a result of this rearrangement, the additional ulna materialized and the olecranon was rotated in the ventral plane.

#### SUMMARY

A case of congenital abnormality of the right arm and hand is presented in which the patient had duplication of the arm bones, terminating in a triple hand.

A survey of the literature fails to reveal a case like this, although duplication of extremities has often been reported.

An attempt is made to arrive at an embryologic explanation for the anomaly.

We may add that the patient feels in no way inhibited by her deformity (except for her shyness) and has absolutely refused any attempts at correction.

We are indebted to Dr. H. Kornfeld, of East Orange, for aid in the discussion of the embryology of this case.

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MACRODACTYLY consists in a congenital overgrowth of one or more fingers or toes. The structures are perfectly normal in character, and merely gigantic in size for the age of the individual.

# THE ECTOPIC KIDNEY—A GYNECOLOGICAL DIAGNOSTIC PROBLEM\*

WITH CASE REPORT

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**A** PELVIC kidney is an infrequent, and, most often, an accidental finding in gynecological surgery. Be-

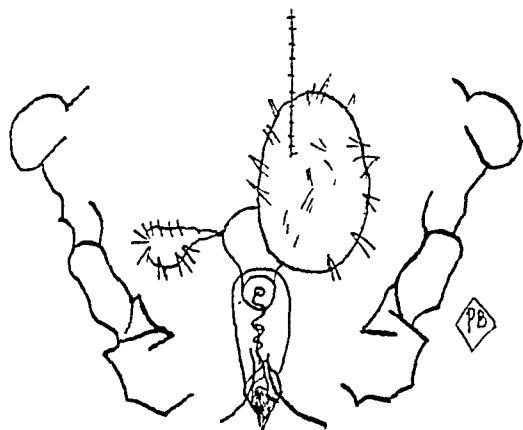


FIG. 1. Diagram of preoperative pelvic findings.

cause of its similarity to pelvic tumors, recognition is quite rare. When accompanied by gynecological symptoms the condition may lead to unwarranted laparotomy, and for this reason its preoperative identification is of utmost importance. When an ensuing hydronephrotic syndrome clinically suggests kidney displacement, intravenous roentgenography and retrograde pyelography are successfully employed for verification of the finding. In the case presented here, x-rays were taken, but, as will be seen, poor visualization of the affected kidney did not seem to warrant a further roentgen study, since the pain was not on the same side.

A brief presentation of this case is worthy of note because of the unusual features and atypical operative findings, which seem to clarify the cause of diagnostic error. The value of painstaking x-ray technique is demonstrated.

D. W., married, age 24 years, music teacher, entered Mt. Sinai Hospital on February 16, 1939. In childhood, she had had pneumonia and bronchitis. The latter recurred several times subsequently. In 1929 her sight was restored by operation after a three months' period of blindness. A left salpingectomy was performed four years before, for an unruptured ectopic gravidity.

The menses had always been normal ( $14 \times 28 \times 4$ ). A six week amenorrhea since the last regular period on December 27, 1938, was followed by profuse, continuous bleeding, accompanied by severe, constant, low back pain and intermittent umbilical pain, which radiated into the medial and anterior aspects of the right thigh. There were also urinary frequency and urgency. Coitus without contraception occurred one week after the last period.

The patient, a short, thin, colored female appeared acutely ill, although the temperature was only  $100^{\circ}\text{F}$ . The pharynx was injected and moist râles were heard throughout the chest. The accommodation response of the pupils was sluggish. Pronounced midline abdominal tenderness was elicited. The left lower abdominal scar was firmly healed.

Upon pelvic examination, moderate uterine bleeding was observed. To the left was a tender, immovable, semi-cystic mass extending from the posterior pelvis to the anterior abdominal wall, to which it was fixed. In the right pelvis the indefinite contour of an adnexal mass could be palpated through thickened parametria. Examination under anesthesia was advised because of marked muscle rigidity.

*Laboratory Findings.* Blood pressure was 122/80. Sedimentation time was over one hour. Hemoglobin was 80 per cent; red blood cells 4,700,000; white blood cells 10,400; 66 per cent polymorphonuclear leucocytes; 30 per cent lymphocytes; 2 per cent eosinophiles; 1 per

\* From the Gynecological Service of Dr. I. C. Rubin, Mt. Sinai Hospital, New York City.

cent mononuclear leucocytes. Urine, Wassermann and Aschheim-Zondek tests were entirely negative. Sputum examination revealed no

opened. The pelvic organs were hidden from view by adherent omentum, and the anterior abdominal peritoneum was firmly attached to



FIG. 2. Operative pelvic findings, showing left ectopic kidney, right bladder vault retracted by right adnexal adhesions and marked chronic pelvic adhesive peritonitis.

tubercle bacilli. The chest x-ray was also negative.

Since the radiation of the pain suggested bladder or right renal tract involvement, an intravenous pyelography was done. Left pelvic concretions, probably phleboliths, were reported. The left kidney, however, was completely obscured by intestinal shadows. The right kidney was normal in size, shape and position. Inasmuch as there were no left renal signs or symptoms, rechecking the left kidney by x-ray was considered unnecessary.

Operation was delayed, however, until the cough subsided. The preoperative diagnosis under anesthesia was: left inflammatory cystic mass, adherent to the anterior abdominal wall underneath the abdominal scar; and also a right tender adnexal mass fixed in the anterior cul-de-sac. (Fig. 1.)

Eleven days after admission, under avertin and ethylene anesthesia, the abdomen was

the omentum overlying and attached to the large left retroperitoneal pelvic mass. (Fig. 2.) The entire right bladder vault was folded back proximally upon itself and fixed to the right adnexal mass by inseparable adhesions.

A small uterus was buried deeply beneath a cluster of seroceles and adhesions to the sigmoid and bladder. No vestige of the left tube was demonstrable. The left ovary, enlarged, cystic and buried, was dissected from adhesions surmounting the lower part of the above described retroperitoneal mass, which extended from the fourth lumbar vertebra into the true pelvis. The mass was firm and size of a grapefruit. It protruded forward and was adherent to the abdominal wall peritoneum underneath the scar.

Upon incising the thickened adhesions and the capsule, the left kidney cortex was observed. The capsule was immediately sutured.

On the right side a large retort-shaped tube and an enlarged diseased ovary were enucleated by blunt and sharp dissection from the anterior cul-de-sac and right bladder vault adhesions.

was 11 cm. long. The wall was 5 mm. wide. The fimbriated end was closed, bulbous and retort-shaped, with surface adhesions. Proximally the lumen was obliterated.



FIG. 3. Postoperative kidney x-ray (intravenous) showing clear outline of a left ectopic kidney.

The right tube and portions of both ovaries were removed, care being exercised to preserve the ovarian blood supply.

*Pathological report* revealed chronic salpingitis and hydrosalpinx; follicle cysts in diseased portion of ovaries. The Fallopian tube

*Postoperatively* there was right lower quadrant pain, tenderness, spasticity and dysuria. Right thigh pain persisted for ten days. There were also a productive cough and râles at both lung bases but these disappeared after eight days. During this time the temperature rose

to 102.8 degrees, but subsided within several days.

Two weeks after operation, March 16, 1939, a second x-ray (Fig. 3) of the urinary tract showed "left kidney in ectopic position in the presacral area."

The patient, observed at the follow-up clinic on May 12, 1939, ten weeks after operation, was free of symptoms. The left presacral mass was palpated very distinctly.

#### SUMMARY

1. An interesting and undiagnosed case of asymptomatic ectopic kidney is presented. The error of omission committed here is of teaching value.

2. Contralateral bladder distortion from chronic inflammatory adhesions produced

the urinary syndrome on the contralateral side.

3. Preoperative x-ray, because of intestinal shadows, did not reveal an ectopic kidney.

4. The importance of proper preparation of the patients for x-ray is stressed by this case. Postoperatively, pyelography confirmed the laparotomy findings of left ectopic kidney.

5. An ectopic kidney should be suspected when a low retroperitoneal pelvic mass is felt, even when it is fixed to the anterior abdominal wall.

6. The rarity of this condition, the atypism of the symptoms, and the instructive elements of the case warrant reporting.



# FALLACIES IN DIAGNOSIS OF RENAL AGENESIS

WITH SPECIAL REFERENCE TO MICROSCOPICAL URETERAL ORIFICES

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THE greatest majority of reported cases of congenital solitary kidney were discovered at autopsy, the patient having died in most cases from causes unrelated to the lesion in the urinary tract. With the advent of the cystoscopic and intravenous pyelography era, the literature became replete with case reports in which a clinical diagnosis of renal agenesis was made. By far the largest series from a single clinic was reported by Braasch and Merriks<sup>1</sup> (sixty-nine cases). They were careful, however, to point out that the diagnosis was definitely established by autopsy or surgical exploration of the absent side only in twenty-seven cases and that in the other forty-two cases it was inferred from roentgenographic and cystoscopic data. A clinical diagnosis of renal agenesis was made in 131 cases of the total 696 cases\* so far reported in the literature but only in forty-one instances, or 31 per cent, was the diagnosis corroborated either by autopsy (seventeen cases) or by operation (twenty-four cases). It is possible that in a number of unproved cases a rudimentary or a totally destroyed kidney really existed on the so-called absent side, which in some instances may have even communicated with the bladder by means of an orifice so minute that its presence could be detected only by microscopical sections.

The diagnosis of a solitary kidney ordinarily is based on the following findings:

1. The apparent absence of a ureteral orifice on one side on repeated cystoscopic examination in an otherwise normal looking bladder. In cases of advanced cystitis associated with thickened mucosa and with extensive edema this finding may not be of

value since the orifice may be extremely difficult to locate. The possibility of an ectopic location of the ureteral orifice must also be considered, as the ureter may end, according to Eisendrath and Rolnick,<sup>2</sup> in the posterior urethra, the seminal vesicles, the vas deferens, or the ejaculatory duct in the male, and in the urethra, in one horn of a bicornuate uterus, in the wall of the cervix uteri, in the vagina, in the vestibule of the vagina, and in the persisting duct of Gaernter in the female.

2. Absence of indigo-carmin elimination on one side.

3. Absence of a kidney silhouette on plain roentgenogram.

4. Absence of elimination of opaque medium on one side in intravenous pyelography.

5. Roentgenographic evidence of renal enlargement and asymmetry of the psoas muscle shadows.

Neither one nor all of the above findings may be an absolute criterion of an absent kidney as may be gleaned from the following:

1. Failure to find a ureteral orifice in an otherwise normal looking bladder. The orifice may be so minute that its presence can be discovered only on microscopic sections. In the classical case reported by Wason,<sup>3</sup> the orificed was so minute as not to be visible to the naked eye and yet allowed urinary drainage. In her case the patient was an infant seven months old, apparently healthy until it was six months of age, when fever, diarrhea, and emaciation developed and death finally occurred. Autopsy showed advanced bilateral hydronephrosis and megaloureter. At the site of the ureteral orifices cystic projections were found which on most careful inspection showed no opening. A solution of thorium was then injected

\* A copy of the complete bibliography on the subject and a chart upon which the above data is based will be gladly mailed by the authors upon request.

into both ureters but it could not be seen to escape through the protrusions. On standing for one hour, however, a small amount of the solution was found to have collected in the bladder. Serial microscopic sections were cut through the bulbous portions of the cyst in search of orifices which were found on both sides.

A somewhat similar case was reported by the senior author.<sup>4</sup> His patient was a boy 4 years of age who had a pyuria, intermittent attacks of pyrexia accompanied by chills, and pain in the bladder and both kidney regions. Since birth the child had been unable to pass urine in a free stream. Examination of the blood showed the presence of malarial parasites. The urine was loaded with pus. The phenosulphonaphthalein output was only  $10\frac{1}{2}$  per cent in two hours; the blood chemistry was, however, normal. Cystoscopy showed a huge cystic swelling situated in the middle and on the left side of the bladder very close to the vesical neck. No orifice could be found on the left side. The intravenous pyelogram showed no elimination on either side. A diagnosis of a bladder cyst obstructing the urinary flow with advanced bilateral infected hydronephrosis was made. On suprapubic cystotomy a huge cyst was found on the left side of the bladder obstructing the vesical neck. This cyst did not contain a ureteral orifice but one was found situated to the left side of the cyst. The child died of uremia within twenty-four hours. Autopsy showed marked destruction of both kidneys, which were reduced to shells, and tremendously dilated ureters. There were two ureters on the left side, one of which ended, apparently blindly, in a huge cystic dilatation within the bladder. Careful scrutiny with magnifying lenses failed to disclose a ureteral orifice over the tumor, but microscopic serial sections cut through the lower end of the ureterocele definitely established the presence of an orifice which measured  $\frac{3}{40}$  cm. in diameter.

The two cases cited above indicate that an apparent absence of a ureteral orifice as determined by an unaided eye is not a

criterion that such a condition actually exists as the ureteral opening may be demonstrated microscopically.

2. Chromocystoscopy. In the presence of a destroyed kidney, with or without a microscopic ureteral orifice, elimination of the dye will not take place.

3. A small atrophic kidney or a shell kidney may exist on the side where its absence is suspected and fail to cast a shadow on x-ray, or the x-ray may be so obscure that no renal silhouette can be made out at all.

4. The absence of dye elimination in intravenous pyelography may be due to a completely destroyed kidney.

Enlargement of the renal shadow, undoubtedly compensatory in nature, is a fairly uniform and a characteristic x-ray finding in cases of solitary kidney, as well as the increased size of the renal pelvis which occurs less frequently. Recently Braasch and Merricks<sup>1</sup> made an interesting observation that in 16 per cent of their cases the psoas muscle shadow was wider and that in 40 per cent there was an occurrence of less sharper definition of the psoas muscle on the side where the kidney was absent. These findings were noted in two out of the nine unpublished cases observed by one of us (R. L. D.) but cannot, of course, be construed as pathognomonic evidence of renal agenesis.

It can, therefore, readily be seen from the above that we really have not a single diagnostic criterion which determines clinically, with absolute certainty, that we are dealing with a congenital absence of one kidney.

The clinical significance of the foregoing lies in the fact that in a case in which a complete urologic survey discloses what appears to be a congenital solitary, but otherwise normal kidney, but which presents unexplained evidence of urinary infection, such as pyuria, pyrexia and pain on the side where the kidney is supposedly absent, an exploratory operation may be indicated to rule out the possible presence of a diseased, functionally dead kidney.



## CASE REPORTS

CASE 1. A 20 year old colored female was admitted to the obstetrical service at Sydenham Hospital, December 12, 1936 with symptoms pointing to toxemia of pregnancy. She was apparently about seven months pregnant, gravida 1, para 0. For the last three months of her pregnancy she had had headaches and ankle edema. At the time of admission she appeared toxic, her blood pressure was 210 systolic, 130 diastolic, and ankle edema was present. Fetal heart sounds were not audible. The eyegrounds showed distended vessels.

The urine analysis disclosed 4 plus albumin, a few red blood cells and a moderate number of pus cells in clumps. The blood examination showed 74 per cent hemoglobin, 4,750,000 red blood cells, 14,300 white blood cells, 70 per cent polys, of which 16 per cent were immature, 16 per cent lymphocytes, and 4 per cent monocytes. The urea nitrogen was 56, uric acid 4.6, and glucose 79. The Van Slyke index was 77.9 (144 per cent of standard clearance).

On the night of admission the patient was delivered of a dead fetus, and improved rapidly thereafter. As her urine continued to be loaded with pus cells and red cells, she was referred to the urologic department for survey.

The plain roentgenogram (Fig. 1) showed a very dense but mottled, huge calcified area over the region corresponding to the position of the right kidney. The shadow extended from the eleventh rib to a level just below the transverse process of the second lumbar vertebra. There was no silhouette of a kidney shadow surrounding this calcified area. In view of subsequent findings which pointed to absence of kidney on same side, this shadow, especially because of its mottled appearance, could have easily been mistaken for one of extrarenal origin.

The intravenous pyelogram (Fig. 2) showed a complete absence of dye elimination on the right side. The left ureteropelvic tract was visualized very well and there was the characteristic compensatory dilatation of the pelvis and all of the calyces and ureter commonly observed in cases of solitary kidney.

Cystoscopy on January 3, 1937 disclosed no ureteral orifice on the right side, and on prolonged inspection indigo carmine, which was injected previously by the intravenous route, was not seen to emerge from any point on that side. On the left side the dye came through in powerful jets of excellent concentration. The

urine obtained from the left kidney was clear and on microscopic examination showed no abnormal constituents. The bladder urine, although laden with pus and red blood cells, showed neither tubercle bacilli nor any other organisms.

Two days later the patient was cystoscoped by another member of the urologic staff with special reference to localization of an orifice on the right side. This time again no orifice could be found on very long and conscientious inspection. The bladder mucosa showed no evidence of any inflammatory lesion. It appeared perfectly smooth and normal throughout, and a ureteral orifice, if present, should therefore have been found with ease.

A tentative diagnosis was made of a tuberculous right kidney undergoing an autonephrectomy through calcification (putty kidney), having an atrophied ureter with a microscopic opening into the bladder. It was believed that the presence of a focus of infection was responsible for the toxemia of pregnancy and that removal of this focus would prevent a similar episode in the future.

An exploratory operation was performed by Dr. S. Malisoff on January 8. A small atrophied right kidney was found which was removed. The right ureter was explored with a probe which could be passed only for a distance of 2 inches. Methylene blue was then injected into the ureteral stump which was then ligated. *One-half hour after the operation urine obtained by catheterization of the bladder was faintly blue and two hours later a specimen had a marked blue color, which proved beyond any doubt that a communication existed between the right kidney and the bladder. This explained the presence of pus in the urine.*

The removed right kidney measured 7 by 4.5 by 2.5 cm., was markedly atrophied, and was covered by adherent perinephritic fat which had undergone fibrolipomatous changes. The capsule stripped with difficulty. On section the kidney was found to consist of many sacs, each filled with a gritty material which had undergone calcareous changes. The sacs also contained a great deal of cheesy material. No actual calculi were present. Unfortunately, after being photographed, the specimen was misplaced so that no microscopic section could be made. Grossly, however, the specimen was undoubtedly that of a tuberculous (putty) kidney.

The postoperative course of the patient was uneventful and she was discharged January 21, 1937.



FIG. 1. Note the huge mottled shadow in the region of the right kidney. Cystoscopy showed no ureteral orifice and no elimination of indigo-carmin on same side. The case could have readily been mistaken for a congenital solitary kidney and an extrarenal calcification on the right side.

Careful search of the literature revealed but one other case, reported by Uthoff<sup>5</sup> similar to the one cited above. In his case, although cystoscopy and intravenous pyelography pointed to the presence of a solitary kidney, an exploratory operation was nevertheless performed on the "absent" side which disclosed a large calcified cystic kidney mass. In his case a female patient complained suddenly of severe pain in the region of the "absent" kidney. As the urinalysis showed pus and blood and as the investigation of the bladder and the opposite kidney showed no evidence of any lesion, we would venture to suggest that in his case, as in our own, blood and pus found its way into the bladder from the destroyed kidney through a microscopical ureteral opening.

McKenzie and Hawthorne<sup>6</sup> emphasize that in 3 of their series of five cases of renal aplasia, pain was for unexplained reason

complained of on the side of aplasia. It can be readily seen that the presence of a rudimentary, trouble-giving kidney, might have



FIG. 2. Same side. Intravenous pyelogram [showed no elimination of dye on the right side. Note the uniform dilatation (compensatory) of the left ureteropelvic tract, characteristic of a solitary kidney.

been entirely overlooked had the maldevelopment reached a slightly higher degree, resulting in the absence of a visible ureteral orifice. In a few of the reported cases of solitary kidney in which cystoscopy did not show a ureteral orifice on one side, pain was for some "unexplained reason" a prominent symptom on the side where the kidney was supposed to be absent.

CASE II. N. S., age 27, a white male, single, was admitted to Sydenham Hospital on June 26, 1936, complaining of high fever, nausea and pain in the pelvic region. There were no symptoms of bladder irritability. The patient denied having had gonorrheal infection but stated that occasionally he had received prostatic massage.

His temperature on admission was 106°F. which gradually returned to normal on July 19. During this time physical examination was entirely negative. The prostate gland as felt per rectum was normal and there was no evidence of urethritis. The x-ray of the urinary tract was unsatisfactory and that of the chest showed no lesion. The urine was laden with pus, blood and

bacteria. Blood cultures were negative at the end of twenty-four, forty-eight and seventy-two hours. The Widal was negative. Blood examina-



FIG. 3. Although all x-ray and cystoscopic findings pointed to absence of a kidney on the right side, an exploratory operation was performed because of unexplained pyuria. Cross section of atrophic tuberculous (putty) kidney removed at operation. The organ measured  $7 \times 4.5 \times 2.7$  cm.

tion for melitensis and typhoid and paratyphoid A and B was likewise negative. The blood chemistry was normal.

On July 20, the patient began to complain of slight burning on urination and his temperature rose again to  $102.4^{\circ}\text{F}$ . and ran an irregular course, going up as high as  $104.6^{\circ}\text{F}$ . until July 31 when it dropped down to normal again.

Three cystoscopic investigations during this period failed to visualize a ureteral orifice on the left side; likewise there was no indigo carmine elimination on the same side. The output of the dye was excellent from the right orifice. The bladder wall was trabeculated and the mucosa slightly reddened. The urine obtained from the right kidney was clear and contained on microscopical examination but an occasional leukocyte.

Two intravenous pyelograms at twelve day interval failed to visualize the left ureteropelvic tract. The right tract showed a moderate dilation characteristic of a solitary kidney.

As every other condition was excluded with a fair degree of accuracy, it was evident that the patient had a urinary tract infection. He had neither the clinical manifestations nor the cystoscopic evidence of acute bladder infection or urethritis and the examination of the right kidney urine likewise could not explain the

source of his heavy pyuria. We suggested that the patient might have an acute exacerbation of an old infection in a destroyed kidney on the left side and that pus and blood found its way to the bladder through a microscopical ureteral orifice. An exploratory operation on the so-called absent side was therefore advised, but the patient refused to submit to it and was discharged from the hospital on October 20, 1936.

#### SUMMARY AND CONCLUSIONS

1. Review of the literature indicates that of 131 reported cases in which a clinical diagnosis of renal agenesis was made, 41 cases or only 31 per cent were confirmed by either exploratory operation or autopsy.

2. The most thorough urologic investigation which includes cystoscopy, chromocystoscopy, plain roentgenography, and intravenous pyelography, cannot completely rule out the presence of a destroyed infected kidney with microscopic orifice on the so-called "absent" side.

3. The ureteral orifice may be so minute that its presence may be demonstrated on microscopic sections only.

4. A case is reported in which complete urologic survey showed what appeared to be a solitary kidney. Because of unexplained pyuria, exploratory operation was done, revealing an autonephrectomized (putty) kidney on the opposite side. Methylene blue injected into the ureteral stump was recovered from bladder shortly after operation, which definitely proved that a communication existed between kidney and bladder, explaining the pyuria.

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# POLYPOSIS OF THE COLON

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GENERALIZED polyposis of the colon is not a new clinical entity, but the realization of the frequent association of this condition with carcinoma of the large intestine has progressively broadened the field of its interest. Articles in recent literature by Erdmann and Morris,<sup>1</sup> McKenney,<sup>2</sup> Rankin and Grimes,<sup>3</sup> Miller and Sweet,<sup>4</sup> Coffey<sup>5</sup> and others, not only emphasize the frequency of malignant degeneration in this condition but call attention to the frequent familial tendency of the disease.

It is generally acknowledged that the lesions are of the adenomatous type and the term "multiple adenomatosis" proposed by Lockhart-Mummery,<sup>6</sup> is a more descriptive terminology but "polyposis" seems to be the more popular expression.

Erdmann and Morris are responsible for the clinical classification of polyposis of the colon into two groups, namely: (1) the adult (acquired type), and (2) the adolescent, or congenital disseminated type. This classification, while not serving to differentiate morphologically the individual variations frequently encountered, does on the whole serve as a useful working basis.

The acquired type presents itself in adult life, usually as a few scattered polypi secondary to frank evidences of chronic inflammation. They are, not infrequently, the precursors of malignant degeneration.

The adolescent (or congenital disseminated type) manifests itself early in life by intermittent diarrhea, rectal bleeding, abdominal cramps, loss of weight and secondary anemia. This is the type in which the familial nature of the disease is evident. Rankin and Grimes point out that these tumors are widely distributed in the colon, frequently extending from anus to

cecum, but that their appearance in the sigmoid and the rectosigmoid regions is approximately eight times more frequent than in any other portion of the colon. This, they point out, is particularly significant in the light of the similar occurrence and ratio of the distribution of carcinoma of the colon, and immediately suggests a relationship.

While the average age of the individuals in which the condition is recognized is around the second and third decade of life, patients as young as 2 years and as old as 70 have been reported.

The diagnosis of the condition is easily made, the simplest means being by the palpating index finger substantiated by inspection through the rectosigmoidoscope. A colon x-ray, in addition, helps determine the extent of the involvement. In other words, if an examination is made that is called for by the patient's presenting symptoms, there should be no excuse for failing to arrive at a proper diagnosis.

The treatment of polyposis of the colon is surgical and when a generalized involvement is encountered, complete removal of the colon is the only assurance against subsequent serious complications. Isolated polyps of the colon may be dealt with individually, either by excision or fulguration by way of the proctoscope or transabdominally, but x-ray studies of the colon should be made at the time to see if polyps higher up can be demonstrated. However, when negative evidence is obtained, one has the feeling that possibly their presence is being overlooked. Just recently, an abdominoperineal resection of the colon was done because of malignancy developing at the site of removal of a polyp by Dr. Straub of our Clinic, nine years previously. In the removed specimen of rectosigmoid there

were other polyps and there may be more proximally situated to the point of excision that will give further trouble.



FIG. 1. X-ray after a barium enema. The filling defects caused by the polyps are characteristic, showing the extent of the disease preoperatively.

More recently, cases have been reported in which the colon has been removed to the rectosigmoid region, the polyps in this area being removed by fulguration and this part of the gut later utilized for anastomosis to the ileum. A permanent ileostomy is certainly to be avoided if this can be accomplished with safety to the patient, but this hardly seemed feasible in the case which we are reporting.

When complete excision of the colon is to be done, a preliminary ileostomy is imperative, since this places the colon at rest and permits a considerable degree of recuperation of the structures before extirpation. The contents of the colon can be thoroughly cleaned out; many virulent bacteria are meanwhile destroyed, making peritonitis at subsequent operation less likely; the loss of blood diminishes and meanwhile the patient's depleted reserve is built up by transfusions; etc. If the rectum is to be preserved,

an initial procedure of anastomosing the ileum to this portion of the gut may be considered, but most observers apparently prefer doing this as the terminal step.

In removing the colon, this may be done in one stage or several, depending upon how the patient reacts to the ordeal. The operation may be discontinued at any time that it seems desirable.

#### CASE REPORT

The patient, a Hawaiian male, aged 20, entered Queen's Hospital on March, 23, 1939, under the care of Dr. Min Hin Li, who made the diagnosis. He had apparently been perfectly well until two months before admission to the hospital, when he developed diarrhea, abdominal cramps, dizziness and chills. The stools were watery and frequently contained gross blood. His appetite was poor and during this time he had lost 20 pounds in weight. General physical examination on admission was negative. Blood examinations at this time revealed 55 per cent hemoglobin, 4,390,000 red cells and a white blood count of 15,900, with polymorphonuclears 78 per cent, eosinophiles 1 per cent, monocytes 3 per cent, lymphocytes 9 per cent. The red cells showed many macrocytes, much poikilocytosis and considerable achromic staining. Repeated stool examinations, including cultures, showed nothing abnormal except for a strongly positive test for blood. The urine was negative, as were the Wassermann and Kahn tests. On March 25 and 30, transfusions of 500 cc. of citrated blood were given; the blood count on April 1 revealed hemoglobin 70 per cent, red blood count 4,780,000, white count 15,200, polymorphonuclears 61 per cent, eosinophiles 3 per cent, monocytes 4 per cent, and lymphocytes 32 per cent.

Digital and proctoscopic examination of the rectum revealed many polypi, but microscopic sections from biopsies of the most suspicious appearing ones showed nothing suggestive of malignancy. There was much oozing of blood from the irritated polyps during this examination. Colon x-rays indicated a generalized involvement of this structure by the polyps.

The temperature record previous to surgery showed only an occasional rise to 99°F.

No relative had apparently suffered from a similar condition. However, it is easily possible that this part of the history might be in error.

The patient left the hospital on April 6, feeling better, but was readmitted eight days later because of a recurrence of the symptoms for

Under spinal anesthesia (pontocaine) a McBurney type of incision was made. The ileum was divided just proximal to its termination in



FIG. 2. Specimen removed at second operation (first operation ileostomy). Appendix at left, with its mucosa also polypoid; cecum and first part of colon. Note the long pedicle of the polyp above, and the size of the one below, backed by white paper.

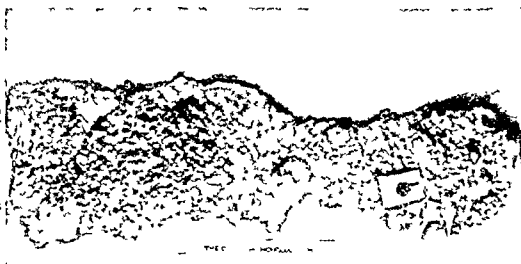


FIG. 3. Specimen removed at third operation, including the second portion of the colon, the splenic flexure, which was not so heavily studded with polypi, and the first portion of the sigmoid.

which he had originally come. Blood examination at this time showed hemoglobin 75 per cent, with 4,530,000 red cells and 25,450 white blood cells, with 75 per cent polymorphonuclears. Stool examinations continued uniformly positive for blood.

the cecum, with the cautery between Stone aseptic intestinal clamps. The distal end was turned in and dropped back. The proximal end of the ileum was mobilized so that it could be drawn out beyond the abdominal wall for approximately 4 inches. This was accomplished by severing the mesentery near the root, first



FIG. 4. Specimen removed at fourth operation, consisting of rectum and perirectal tissues, sliced longitudinally to show muscular and mucosal layers.

It was felt at this time that there was no treatment for this condition except surgery, and that a complete removal of the colon was necessary due to the large number of polypi visible and palpable in the rectum. The patient was transfused on April 19 and 24 and the first stage operation was done on April 25.

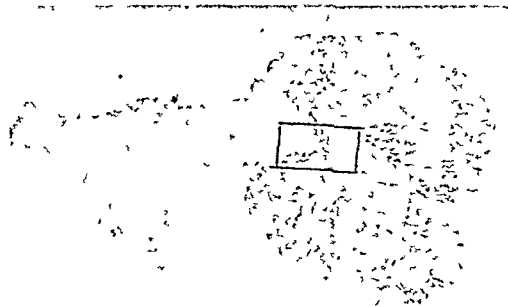


FIG. 5. Very low power ( $3\frac{1}{2}$  times enlargement) of an entire polyp, showing, on the right its stretched base of relatively normal colon mucosa, on the left the structure of the polyp itself.

compressing the vessels before severing, to see if the circulation in the ileum to be mobilized remained adequate. It is a point worth remembering that only a small amount of mesentery can be divided near the bowel without interfering with the circulation, while a considerably greater amount can be divided near the mesenteric root without trouble, due to the anastomosing loops of vessels distal to this region.

The proximal ileum was drawn well out of the wound, attached to the peritoneum and fascia, and the incision closed around it. A large sized Pezzer catheter was then placed into the pro-

truding ileum and the gut wall inverted around it. By this means the intestinal contents during its most irritating period, was conveyed away

were closed up to the protruding colon, the Stone clamp was again applied, the gut cut off with a cautery and an aseptic closure of the gut



FIG. 6. Low power photomicrograph of the area outlined in Figure 5, showing normal structures at the right, below, and the adenomatous polypoid structures above and at left. Note the difference in the character of the glands, and the loose gelatinous type of the stroma of the polypoid portion.

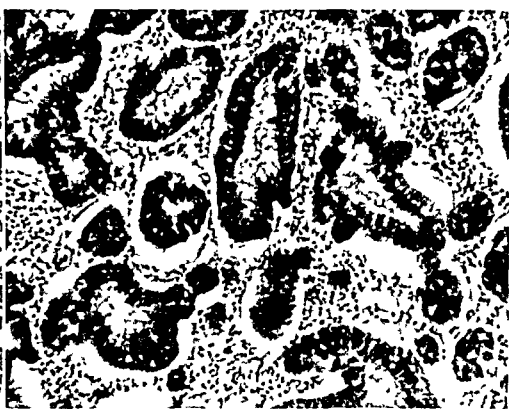


FIG. 7. High power photomicrograph of central portion of a polyp to show the mucoid type of the essential cell of the gland, and the loose, gelatinous type of the stroma.

from the abdominal wall and at no time during the postoperative period was there excoriation of the skin. Tube drainage of the intestinal contents was successful for two or three weeks. After removal of the tubes the skin was protected by zinc oxide sprinkled with kaolin and overlaid with vaseline gauze.

Between the first and second operations, the patient was given another transfusion of 500 cc. of blood.

On May 12, or seventeen days after the first operation, again under spinal anesthesia, a long left rectus incision was made with a transverse incision to the right across the right rectus muscle between the umbilicus and the costal margin.

The cecum and ascending colon were mobilized by an incision along the lateral side, the vessels ligated, and the dissection carried over to the region of the splenic flexure. The omentum was freed from the transverse colon and preserved. Posteriorly, the ureter and duodenum were identified and protected. The dissection was rather difficult due to adhesions, edema, and the enormous size of the mesenteric glands. Examination, microscopically, of some of these glands revealed no malignant deposits. By the time the splenic flexure had been reached, the patient's condition did not justify prolongation of the operation. The incisions

lumen carried out, following which it was dropped back into the abdominal cavity and the incision closed. The patient was given 500 cc. of blood and intravenous saline and glucose during the operation.

On May 30, eighteen days following the second operation, a third operation was done under spinal anesthesia. A left rectus incision was made with transverse incision across the left rectus muscle in the splenic region. The remaining colon was removed into the hollow of the sacrum. The superior hemorrhoidal artery was preserved in order to prevent loss of viability to the upper end of the rectum. The distal end of the colon was inverted, dropped back and covered over by peritoneum from each side of the pelvis, forming a diaphragm of peritoneum between the upper and lower pelvis similar to that formed during an abdominoperineal resection for carcinoma of the rectum. The raw areas left by removal of the colon were closed over by sewing together the leaves of the colonic mesentery. Through an extraperitoneal stab wound in the left McBurney region, a rubber tissue drain was carried down to the stump of the distal colon and one carried upward below the left renal area.

Again, the patient was supported during operation by intravenous saline and glucose and by a blood transfusion.

Twenty-seven days after the third operation a fourth was carried out with the patient under spinal anesthesia, in prone position, with head

lowered, feet lowered, and legs separated. A longitudinal incision over the midportion of the lower sacrum was carried down and around the anus. The coccyx was removed. The rectum and anus were then extirpated without much difficulty, after ligating the middle hemorrhoidal vessels. The cavity remaining was packed with vaseline gauze and rubber tissue drains and the wound partially sutured around these drains. The patient was again transfused at the completion of the operation.

One month after the last operation, the patient was doing well, and the fecal discharge from the ileostomy was becoming more solid and less frequent.

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THERE is ample proof that polyposis intestini is an inheritable disease, and Dukes has published charts and thirteen family pedigrees which are most convincing on this point.

THE brief excerpts in this issue have been taken from "Manual of Surgery" by Rose & Carless (Williams & Wilkins Company).



# HYPERPARATHYROIDISM

## REPORT OF A CASE OF PARATHYROID ADENOMA WITH CYSTIC DISEASE OF THE BONES

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THE interest of the orthopedic surgeon in diseases of the parathyroid glands is centered chiefly in the cases of hyperactivity of these organs causing a loss of the calcium content of the bones with resultant osteoporosis, deformity of the limbs and pathologic fractures. Stimulated by the work of Ballin of Detroit, the members of my staff at the Hospital for Joint Diseases and I have been carefully scrutinizing all bone lesions which come under our care for evidences of hyperparathyroidism. Cases of arthritis, localized and general osteoporosis and cystic disease of bones have been thoroughly studied, with particular reference to the serum calcium and phosphorus and the phosphatase. Our attention has been focused on the significance of these chemical changes through the work at our hospital of Dr. Henry L. Jaffe and his associates, whose studies are well known to many in the profession. Yet it was not until recently that there came under our care a patient exhibiting the characteristic manifestations of hyperparathyroidism arising from an adenoma of one parathyroid gland, the first case, I believe, in the records of our institution. The experiences of this patient so accurately mirror the changes in hyperparathyroidism and the effects of surgery that they are worth reporting in detail.

### CASE REPORT

The patient, a man of 49, had been known to me for fifteen years, but consulted me professionally for the first time in September 1935 for what appeared to be an idiopathic left sciatic neuralgia. This was readily relieved by simple physiotherapeutic measures. Certain observations were made then which did not seem very significant, but which in retrospect have manifestly an important bearing both on his present condition and perhaps, too, on the

etiology of the sciatica. The history suggested that the patient's height had diminished somewhat during the preceding few years. A condition of stooped or round shoulders which had been present for many years was said to have become exaggerated. I found a moderate right dorsal idiopathic kyphoscoliosis known to have been in existence for many years. An increase of this deformity would reasonably explain the reduction in the height, the exact extent of which was uncertain. I noted also an enlargement of the head, but did not appreciate that this was pathologic, since I did not have a clear recollection of its previous size and shape. There were no neurologic disturbances. An x-ray film of the pelvis revealed an asymmetry which I considered as secondary to the scoliosis. The bones of the pelvis revealed no alteration in their architecture other than the morphologic change. Since the sciatica yielded to treatment, the man resumed his work as a printing compositor and I dismissed the case from my mind.

The patient returned three years later, on February 11, 1938, because of a fracture of his left arm which had occurred three months previously during a rather mild effort to go through a narrow doorway by pulling himself up with his left hand holding on to the framework of the door. More significant was the presence of symptoms of a severe systemic disturbance. He had grown progressively weaker so that he could walk only a few blocks at a time, and because of this, he had given up his work some time before the fracture incident. As his wife conducted a boarding house he contented himself doing odd jobs around the house. But willing as he was, he had little resistance, and even mild efforts tired him readily. He had lost some weight and several inches in height, his lower limbs had become bowed and his head was enlarged, noticeably so now to his wife and friends.

The examination showed a greatly changed individual. His stature was decidedly shortened; his skull was enlarged and by contrast his

face was small; his back presented a severe kyphoscoliosis with telescoping of the chest into the pelvis. The thighs were bowed outward. He walked slowly, awkwardly and with a waddling gait. His voice was weak. He appeared asthenic. In the left arm he had an ununited pathologic fracture of the shaft of the humerus. (Fig. 1.)

It was now, of course, apparent that we were dealing with a lesion that had produced a profound constitutional disturbance which was very marked in the osseous system. A parathyroid tumor was suspected and the patient was admitted to the Hospital for Joint Diseases for further study. Roentgen ray films were made of the entire skeleton. These showed very extensive involvement of many of the bones.

TABLE I

BLOOD CHEMISTRY IN A CASE OF PARATHYROID ADENOMA

	Cal- cium	Phos- phorus	Phos- phatase	Urea N	N P N	Sugar
Preoperative 2/14/39	13 0	2 ~	23 1	31	54	92
Operation 2/26/38						
Postoperative 2/28/38	8 4				80	97
3/8/38	5 4	2 8				
3/11/38	5 8					
3/14/38	5 8	3 4				
3/22/38	5 2	4 2			32	
3/28/38					31	
3/30/38	5 0	5 1				
4/6/38					33	
4/8/38	5 6	4 3				
4/18/38					34	97
4/21/38	5 9	4 0				
4/25/38	6 2				39	
5/2/38					33	
5/3/38	6 1	4 0				
5/10/38	7 0	3 8			34	
5/16/38	8 0	3 4			34	101
7/28/38	8 3	3 9				
3/3/39	10 2	2 9	4 4			

X-ray examination of the skull disclosed extreme thinning of the tables of the bones with complete loss of the trabecular markings (Fig. 2) but no definite tumor formations. There was extreme atrophy of the inferior maxilla with a large cyst in the symphysis. An extreme kyphoscoliosis of the dorsal spine was accompanied by pronounced wedging of all the vertebrae, associated with marginal hypertrophic changes. The ribs showed marked osteoporosis. In the scapulae there was almost complete loss of all bone detail due to resorptive changes. The lumbar spine also disclosed extreme generalized osteoporosis. No compression fractures were noted and the kidney showed no calculi. In the pelvis there was extreme generalized osteoporosis without tumor formation.

The left humerus (Fig. 1) showed evidence of a pathologic fracture through the middle third of the shaft and a large medullary tumor in the



FIG. 1. Pathologic fracture of left humerus. Note cystic condition at site of fracture and lack of callus. There is marked demineralization. Cortex is very thin.

same area. The alignment of the fragments was good but no callus formation was present. In the proximal extremity of the humerus extreme cortical thinning with granular disintegration was noted. The right humerus had a patchy area of osteoporosis at the junction of the proximal and middle thirds of the shaft, associated with moderate cortical thinning. The bones of both hands (Fig. 3) exhibited extreme osteoporosis with marked cortical thinning, presenting likewise the granular disintegration noted in the left humerus. Concentric atrophy was present in the shafts of the intermediate phalanges of the second, third, fourth and fifth fingers on the right side as well as of the shaft of the proximal phalanx of the fifth finger. Extreme cortical thinning of the right radius and ulna was more marked in the distal extremity of the ulna.

A large medullary tumor was present in the proximal third of the shaft of the right femur and in the proximal and middle thirds of the shaft of the left femur. Generalized osteoporosis

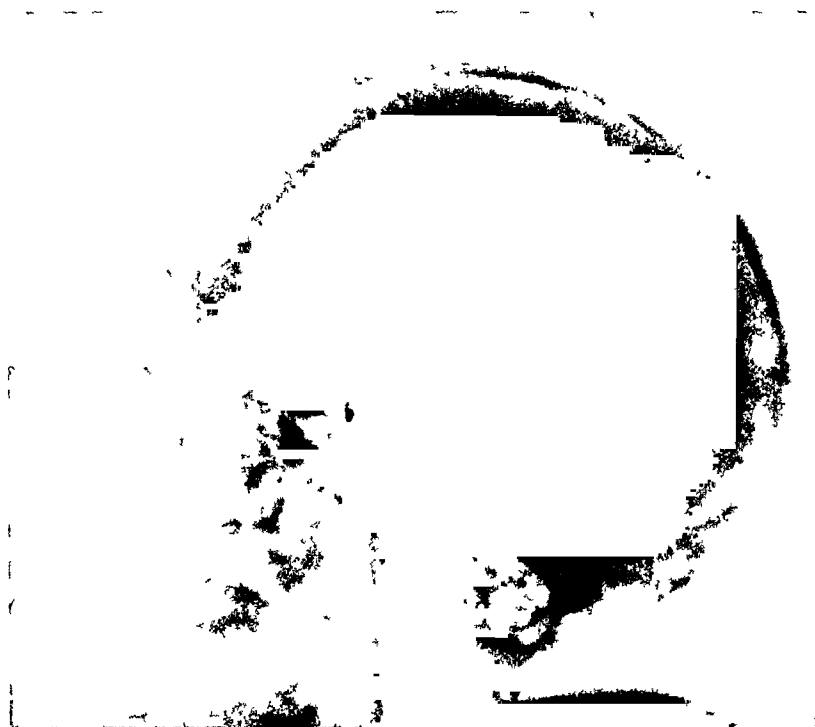


FIG. 2. Extreme thinning of bones of skull. Inferior maxilla markedly atrophied with large cyst in the symphysis shown in other views of skull.

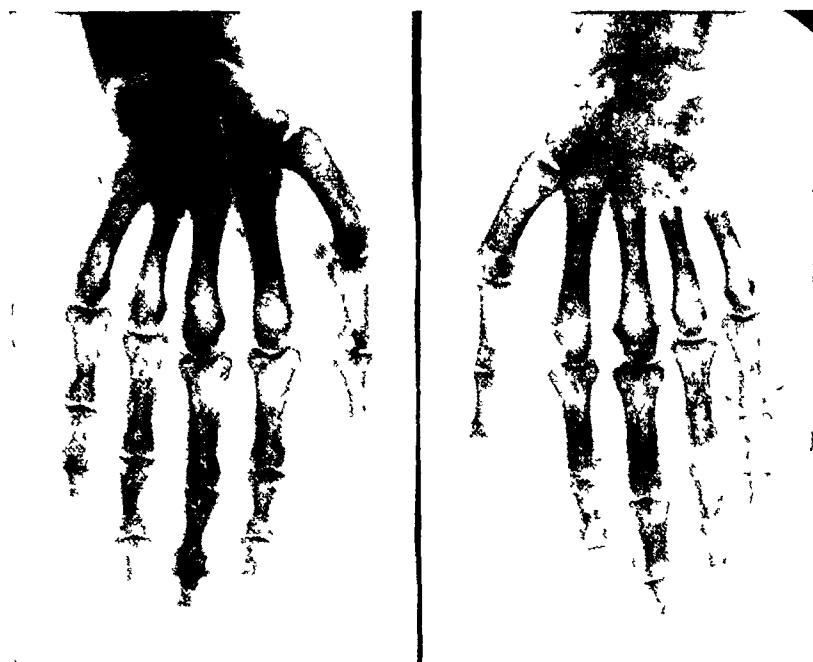


FIG. 3. Marked osteoporosis and cortical thinning. Note concentric atrophy in middle phalanges.

sis, but without the extreme cortical thinning, was seen in these bones also. Another large medullary tumor appeared at the junction of

thyroid gland, of the size of a small lemon. The other parathyroids were found to be normal in size, number, location and appearance.

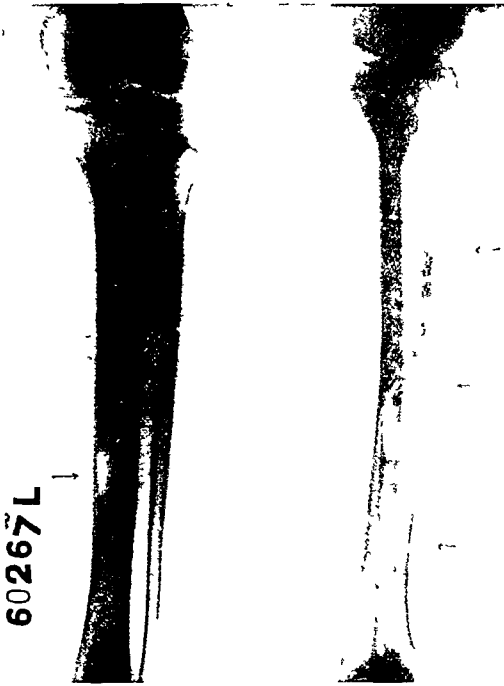


FIG. 4. Cystic area in shaft of left tibia. Marked resorption of anterior cortex.

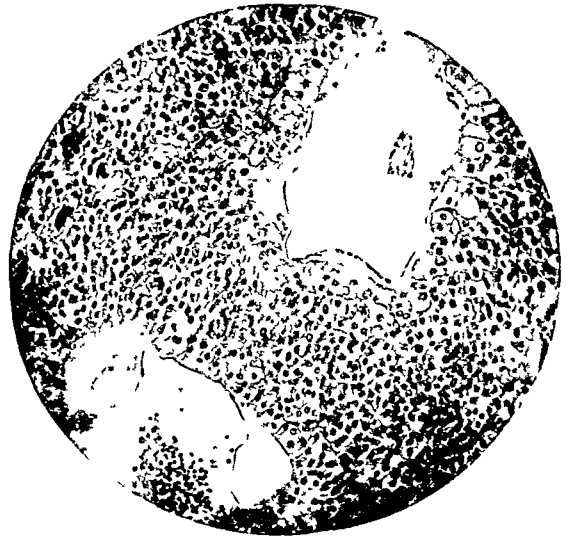


FIG. 5. Adenoma of parathyroid gland.

the middle and distal thirds of the shaft of the tibia (Fig. 4) while the anterior cortex of the tibia had been practically completely resorbed. In the right tibia a tumor had developed at the proximal third of the shaft. The bones of both feet disclosed marked osteoporosis without any evidence of tumor formation.

Studies of the blood showed that the serum calcium (Table 1) was high and the phosphorus low, while the phosphatase was very high. There was in addition, a moderate secondary anemia. The sedimentation rate was 50. The Wassermann and Kahn tests were negative.

There seemed no doubt that we were dealing with a case of hyperparathyroidism (Drs. Jaffe, Bodansky and Pomeranz concurred). Dr. Milton Bodenheimer of the general surgical staff was invited to examine the patient. He thought that he felt an unusual mass in relation to the left lobe of the thyroid. The patient stated that he felt a mass in his neck moving during swallowing. However, other consultants were not certain of the presence of any tumor. Dr. Bodenheimer operated on this patient under general narcosis on February 26, 1938. He found and removed a tumor of the left inferior para-

The tumor measured approximately 3.5 cm. in diameter and weighed 13 Gm. It was encapsulated and on section appeared very cellular. The cut surface had a grayish-yellow glistening appearance with small, irregular areas slightly more translucent.

Beneath the covering of dense fibrous tissue, the neoplasm was composed for the most part of a diffuse proliferation of moderately large polyhedral cells. The nuclei were moderately large, round, possessed a nuclear membrane, and showed a definite chromatin network. Others were more hyperchromatic and tended to be solid. An occasional nucleus showed a nucleolus. No mitotic figures were seen. The cells possessed abundant cytoplasm, granular and slightly eosinophilic. Water-clear cells were present but only near several areas of degeneration. The tumor contained numerous fine vascular channels and fibrous septa, but no attempt at gland formation was noted.

The pathologic diagnosis was chief cell adenoma of the parathyroid gland.

The patient was somewhat depressed for several days after the operation, but at no time seemed dangerously ill. Directly after the operation he received an intravenous injection of saline solution containing calcium gluconate and glucose, and thereafter he received calcium lactate and viosterol daily. The serum calcium dropped rapidly after the operation to 8.4 and

continued to drop more slowly so that at the end of a month, on March 30, 1938, it was 5 mg. per 100 c.c. of blood. The phosphorus in the meantime rose from 2.7 to 5.1.



FIG. 6. Postoperative x-ray fracture of left humerus healed. Cortex thickened. Porosis of bone diminished.

Clinically this patient was doing well and the operative wound healed by primary union. Hoarseness was noted on the day after operation, due to paralysis of the left vocal cord, evidently from involvement of the left recurrent laryngeal nerve. However, this vocal difficulty ultimately completely disappeared.

By March 9, 1938, eleven days after the operation, the patient was well enough to get out of bed. All during this time he had a positive Chvostek sign and at times showed restlessness and twitching of the eyelids, suggestive of latent tetany. On the night of March 11, thirteen days after the operation, his temperature suddenly rose to 103.5, he became very restless and noisy and had some difficulty in breathing, and became violent in his muscular activities. He was promptly given calcium gluconate intravenously and parathormone intramuscularly. Thereafter he received parathormone and calcium lactate daily until April 1, 1938. He improved a great deal and his temperature receded to normal.

Since April 1, 1938 the patient has continued to take calcium lactate and viosterol. His blood calcium gradually rose so that by May 16, 1938

it was 8.0; phosphorus was 3.4 and phosphatase fell from 23 to 4.0.

On May 20, 1938 the patient's general condition was good and his strength increasing. Firm union of the fractured humerus had occurred and x-ray plates showed an increase in bone deposits, especially in the long bones.

A year after the operation the patient was greatly changed: he was alert and ambitious, walked briskly and had acquired considerable physical endurance as compared with his former listless, weak state. A new set of x-ray films showed complete healing of the left humerus (Fig. 6) and a reduction of the cystic areas. The bones still looked atrophied and "washed out," but much less so than a year before. The general haziness was diminished and there was much more definite differentiation between the medulla and the cortex in all the long bones. The cyst in the shaft of the left tibia had almost completely disappeared. Similarly the cyst in the left femur was greatly reduced and the cortex of this bone had increased in density. The blood chemistry was almost normal. On March 3, 1939 the serum calcium was 10.2, the phosphorus 2.9 and the phosphatase 4.4.

#### DISCUSSION

The original clinical picture, characteristic of hyperparathyroidism, included progressive weakness, enlargement of the skull, deformity of the spine and the lower limbs and a pathologic fracture of the left humerus. The diagnosis was confirmed by roentgenograms which showed a generalized demineralization and osteoporosis with an occasional cyst-like formation, and by the blood chemistry changes, marked hypercalcemia, hypophosphatemia and increase in phosphatase.

The postoperative reaction in this case was a hypoparathyroidism and tetany, including a marked drop in the blood calcium, a rise in phosphorus, restlessness, hyperactive reflexes and, finally, about two weeks after the operation, convulsions and a rise in temperature. The loss of parathyroid secretion was compensated by the administration of parathormone, calcium gluconate or lactate and viosterol.

The patient is now well on the way to a complete cure.

# BILATERAL COMPLETE SYNDACTYLISM OF ALL FINGERS\*

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**S**YNDACTYLISM of the fingers of one or both hands of various degrees is a frequent congenital deformity. Com-

(Fig. 1.) Scars of the plastic operations were visible and, although there remained some webbing, she had fairly good function of the

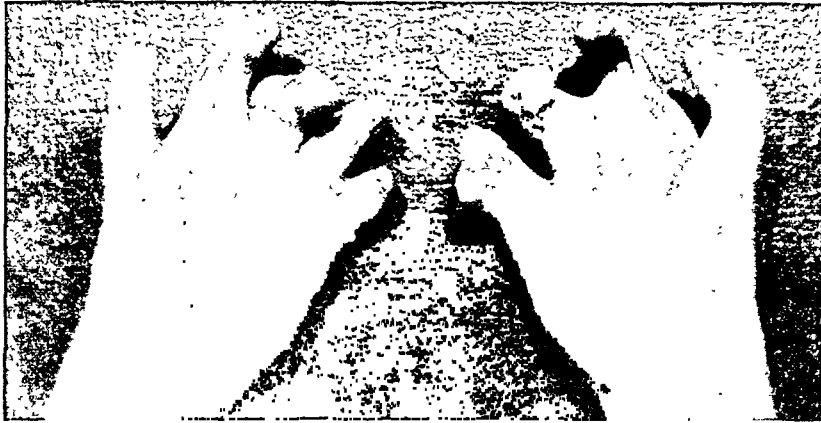


FIG. 1. Mother's hands. One finger has been removed with part of the corresponding metacarpal.



FIG. 2. Hands of younger sister of patient showing complete syndactylism of all fingers.

plete involvement of all the fingers of both hands is, however, most unusual.

## CASE REPORT

A male infant was brought to the hospital at the age of  $1\frac{1}{2}$  years with a deformity of both hands existing from birth. The mother, age 21 had also had a deformity of both hands at birth. A photograph taken when she was  $1\frac{1}{2}$  years of age showed syndactylism of the fingers on both hands, but the exact degree could not be definitely made out. She had then been operated on and five fingers constructed on one hand and four on the other.

fingers. Roentgenograms of her hands showed six metacarpals present on both the right and left hands, the extra one having been partially resected with the removal of the corresponding finger.

A recently born sister of the patient has complete syndactylism of all the fingers of both hands.† (Fig. 2.)

The patient had no abnormality of the head or of the special senses. Chest, abdomen, and spine were normal. The right and left hands

† Since submitting this paper similar operations have been performed on the sister of the patient restoring five fingers on both hands. (Figs. 8, 9 and 10.)

\* From the Shriner's Hospital for Crippled Children.

were about the same in general appearance. (Fig. 3.) The fingers were joined together with skin extending up to the finger nails. Uniform

The treatment consisted of a series of six plastic operations over a period of nine months from August 3, 1938, to May 3, 1939. Sufficient

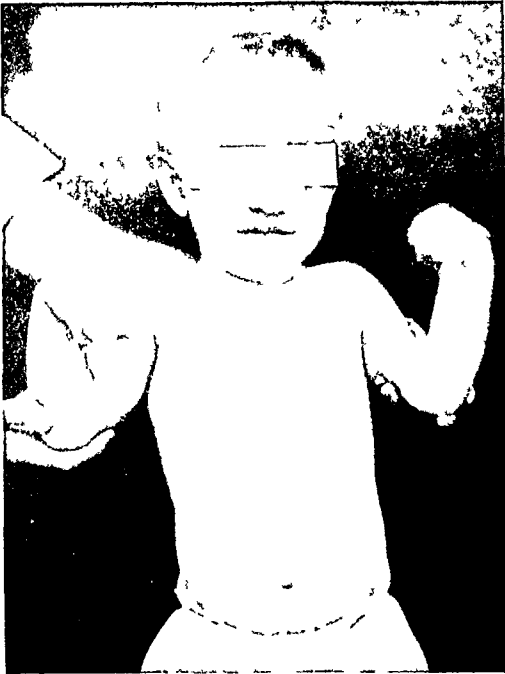


FIG. 3.

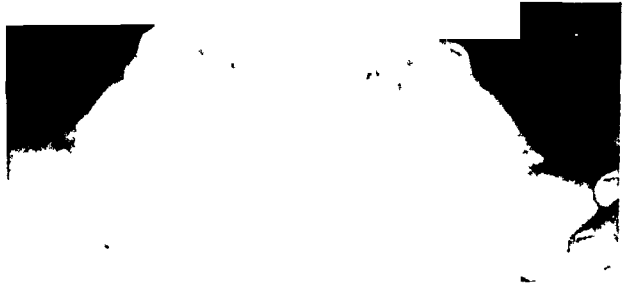


FIG. 4.

FIGS. 3 AND 4. Wayne, Mc Patient before operation showing complete syndactylism of all fingers of both hands



FIG. 5. Wayne, Mc. Roentgenogram showing six metacarpals with multiple extra phalanges.

flexion of the fingers gave the hands a cup-shaped form. (Fig. 4.) There were at least eight finger nails, some of which were fused together. Several of the extra fingers were quite rudimentary. Motion was limited, representing a combined movement of all the fingers. On roentgenographic study a conglomerate mass of phalanges was seen in various shapes and sizes, with six metacarpals on both hands. (Fig. 5.)

time was allowed between the operations to allow the infant to recuperate and also to attain the full effect of each operative procedure.

The following operations were performed:

1. Right hand. Three clefts were formed by cutting down between four sets of phalanges. The defects were covered with split skin grafts from the abdomen.
2. Left hand. Two clefts were formed by cutting down between three sets of phalanges.



FIG. 6. Wayne, Mc. Fingers after operation upon patient shown in Figure 3. Six fingers on each hand, one of which is to be sacrificed later.



FIG. 7. Wayne, Mc. Roentgenogram of hands after operation.

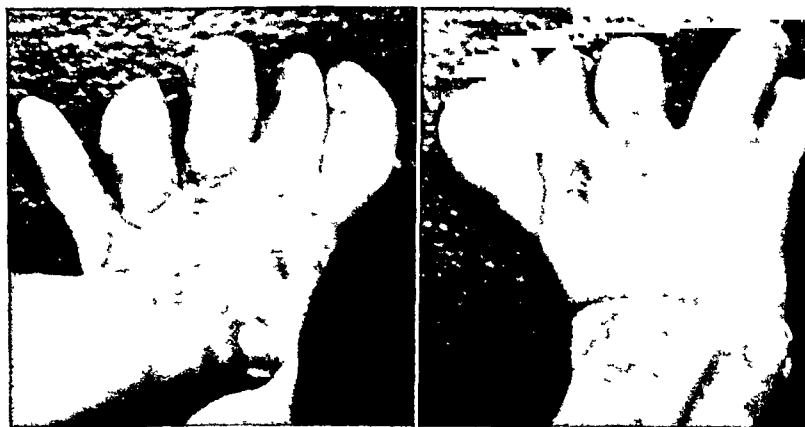


FIG. 8. Vesta McM. Palmar view of hands after operation showing five fairly well formed digits.



3. Right hand. Modified Didot operation further to separate the three units. Removal of accessory fingers, rudimentary finger.

6. Right hand. Plastic operation between thumb and adjoining finger. Deepening of cleft between two other fingers.



FIG. 9 Vesta McM. Dorsal view of hands after operation.



FIG. 10 Vesta McM. Patient feeding herself with one hand

4. Left hand. Didot operation between middle set of fingers.

5. Left hand. Separation of two remaining sets of fingers.

Six fingers were formed on each hand. (Figs. 6 and 7.) The function of the fingers, considering the short time since operation, has been quite good. The patient can use the fingers of either hand for picking up small objects and for doing many useful things. It was thought advisable to allow the six fingers to remain for about a year in order to determine which was the least useful. At a later date it is contemplated to sacrifice one finger and perform whatever additional plastic work will be necessary.

#### SUMMARY

1. Two cases of complete bilateral syndactylism were found in brother and sister. The mother of the patient had had a severe syndactylism of both hands. These deformities are of congenital origin and represent a regressive atavistic trait.

2. Restoration of six fingers with their corresponding metacarpals was secured on both hands in the one patient reported in this paper. He is able to do many things with either hand that he could not do before the operation.



# ACUTE CARDIAC COMPRESSION RESULTING FROM THE RESTRAINING INFLUENCE OF THE PERICARDIUM DURING ACUTE DILATATION OF THE HEART\*

OBSERVATION OF THREE CASES DURING PERICARDIAL EXPLORATION

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FROM first appearance, the title of this paper seems paradoxical—that the heart should be compressed by dilatation. However, such apparently is the case when dilatation is inhibited by the constricting influence of a pericardial sac that has reached its limit of elasticity.

In his discussion of the cardiac compression triads, Beck<sup>1</sup> lists intrapericardial hemorrhage as the most important cause of the acute cardiac compression syndrome. Hemorrhage may be the result of trauma, rupture of a myocardial infarct, a leaking aneurysm, and hemorrhage from neoplasms, scurvy, purpura and tuberculosis. Acute cardiac compression may be caused also by collections of exudates, transudates, and gas in the pericardial sac.

It is the purpose of this paper to present yet another possible cause of the acute cardiac compression syndrome based on the observation of three cases, two of which were operated upon by the author, and a third at which he assisted. This cause is the restraining effect exerted by the pericardium during acute dilatation of the heart.

Numerous series of gunshot and stab wounds have been reported from the larger charity institutions, especially throughout the south. Among these reports wounds of the heart have not been uncommon. Elkin<sup>2</sup> and Bigger<sup>3</sup> have recently summarized the diagnosis and treatment of these extreme surgical emergencies.

The surgical service of the University of Louisville and the Louisville City Hospital have treated a considerable series of heart wounds (Cox,<sup>4</sup> Mayer,<sup>5</sup> Griswold and

Drissen<sup>6</sup>). The idea that the pericardium may be responsible for cardiac tamponade during acute cardiac dilatation, first presented itself during an operation carried out by the author at the Louisville City Hospital, on a patient with a stab wound of the chest.

CASE 1. W. S., a colored male, 40 years of age, was admitted February 20, 1938, thirty minutes after having been stabbed in the chest during a drunken brawl. He was orthopneic and complained of pain in the left shoulder and beneath the left scapula at the level of the fifth dorsal spine. (This physical finding of referred pain to the left shoulder and beneath the left scapula is interesting in that the same distribution of pain occurred in three other cases coming to autopsy, in which leakage of aortic aneurysms into the pericardial sac had produced cardiac tamponade.<sup>7</sup>) He presented a picture of severe apprehension and fear of impending catastrophe. His temperature was 97, pulse 70, respiration 30 and blood pressure 82/50. There was a minimum of external bleeding. There was a penetrating wound 1 cm. long in the third interspace, 3 cm. to the left of the sternum. The lungs were clear to auscultation and percussion. Cardiac dullness appeared to be within normal limits. Heart sounds were distant and barely audible, and there was distention of the neck veins. During examination the patient suddenly collapsed and became comatose and cyanotic. The blood pressure could not be obtained. He was taken to the operating room immediately and intravenous fluids started.

Under positive pressure cyclopropane-oxygen anesthesia, the chest was opened through a left parasternal incision with the horizontal limb of the incision extending laterally just below the nipple. The pectoral muscles were

\* From the Department of Surgery, University of Louisville, and Louisville City Hospital.

reflected from the chest wall and the second, third, and fourth costal cartilages with the tips of the adjacent ribs, resected. The knife blade had entered the thoracic cavity 2 cm. lateral to the sternum. There was no blood in the pleural cavity and no injury to the pericardium could be seen from our exposure. The pericardial sac was very tense and appeared to be distended. In order to establish definitely whether the heart had been injured, it was decided to open the pericardium. While the pericardium was being split from base to apex, the heart bulged into the operating field as though it had been released from a tightly constricting covering. The normal amount of clear serous fluid escaped. Immediately the blood pressure became perceptible and rose to 90/50. During the next ten minutes of observation the circulation continued to improve and the heart returned to normal size. The pericardial edges were easily approximated with interrupted silk sutures. A 3 cm. opening in the one end of the pericardial incision was left for drainage into the pleural cavity. This method of draining the pericardium into the pleura suggested by Griswold,<sup>8</sup> insures against the recurrence of tamponade from excessive postoperative effusion.

The patient returned to the ward in good condition with a blood pressure of 80/50. During the next four hours the pressure gradually increased to 110/88 and became stable at that level. No additional intravenous fluids were given for fear of throwing additional burden on the heart. Convalescence was uneventful and the patient was discharged with a pressure of 125/95.

Shortly after Case 1, a second opportunity to observe the same phenomenon occurred. This time the unfortunate patient served unwittingly as a subject for the artificial production of acute coronary occlusion.

**CASE II.** M. L., a colored female 20 years of age, was admitted March 8, 1938, about twenty minutes after having been stabbed in the chest with a pocket knife. Her temperature was 96, pulse 60, respiration 30, and blood pressure imperceptible. She was in profound shock, gasping for breath and did not respond to interrogation. Her breath smelled of liquor. The knife blade had entered the left chest in the fourth interspace, 2 cm. from the sternum. External hemorrhage, as evidenced by blood on

the clothing, was moderate. Heart sounds were feeble and distant, rhythm regular, neck veins distended and cardiac dullness increased. There were no physical signs of pneumothorax or hemothorax.

The patient was taken to the operating room without delay and intravenous fluids started. Under positive pressure cyclopropane-oxygen anesthesia, the heart was exposed through a left parasternal incision, with resection of the third, fourth and fifth costal cartilages and the adjacent rib tips. The left pleura contained no blood. A laceration was found in the pericardium immediately beneath the external wound. On incising the pericardium from base to apex, the hemorrhagic tamponade was released and the heart resumed rapid activity, resulting in a terrific hemorrhage. The laceration in the heart was 6 mm. long, and had perforated the right ventricle immediately adjacent to and parallel to the right border of the descending ramus of the left coronary artery, in its proximal third. Hemorrhage was controlled by silk sutures deep in the ventricular wall, parallel to the laceration on either side. Free ends of the sutures were twisted to form a single strand on each side of the wound and then tied over the wound as a single suture. Several such sutures were required to control the hemorrhage. Although the coronary artery was not encircled by the sutures, it must have been occluded by the inverting effect. On control of hemorrhage from the heart, the blood pressure immediately rose to 120/80 and became stable. The heart, observed for fifteen minutes, became progressively cyanotic most markedly at the apex. To decrease the possibility of cardiac arrhythmia as a result of handling the heart, 2 per cent novocaine solution was dropped over the surface of the heart early in the operation. The value of this procedure has been worked out experimentally by Mautz.<sup>9</sup> The cardiac rhythm remained regular and the blood pressure elevated, so it was hoped that the heart muscle had enough circulation to maintain activity. The pericardial edges were approximated without difficulty, using interrupted silk sutures, leaving a decompression opening into the pleural cavity at one end of the incision. The chest wall was closed in layers. As the skin sutures were being applied, the blood pressure suddenly disappeared. This was approximately twenty-five minutes after occlusion of the coronary artery.

It was feared that the coronary obstruction was responsible for what had happened, but to make certain that the heart wound was not leaking, the chest and pericardium were reopened. On release of the sutures in the pericardium, the heart fairly popped from the pericardial sac under great tension. The blood pressure instantly jumped to 160/120. The heart had become enormously dilated and bulged through the window in the chest wall. This presented another serious problem as the heart now began to lacerate itself against the ragged rib ends before it could be protected. This resulting new hemorrhage was as troublesome to control as the original heart wound. The entire heart was now extremely cyanotic. Edges of the pericardial sac were separated by 5 cm. and by no amount of tension on clamps fastened to the edges of the pericardium could the sac be pulled over the heart. Approximately forty-five minutes after the coronary artery had been occluded the heart stopped suddenly in diastole. Cessation of activity was preceded by no irregularities. After the heart stopped beating it could be compressed into a mushy mass, similar to that seen in toxic hearts at the autopsy table.

In retrospect, we feel that it is possible that this patient's life might have been saved had deep mattress sutures been used to close the heart wound, thus leaving the coronary vessels unobstructed on the surface of the heart. Some of these important technicalities, unfortunately, are overlooked when one is working under pressure, and on such an elusive object as a rapidly beating heart.

The next case had been reported previously by Mayer<sup>5</sup> in a series of cases from the Louisville City Hospital. It is the author's opinion that the case warrants reinterpretation in view of the above observations, and with Mayer's permission, it is re-presented here.

CASE III. H. T., a colored female 43 years of age, was admitted September 7, 1934, a short time after having been stabbed over the pericardium with a pocket knife. She had been drinking heavily and was irresponsible. Her temperature was 98, pulse 58, respiration 20, and blood pressure imperceptible. The patient

was very restless and apprehensive. In the fourth interspace, 6.5 cm. to the left of the sternal border, was a penetrating stab wound 1 cm. long. The clothing revealed little evidence of external blood loss. Physical signs showed an increase in cardiac dullness, but no evidence of pneumothorax or hemothorax. Heart sounds were regular but distant and weak. Neck veins were distended and the venous pressure in the antecubital vein was 24 cm. of saline. A portable film of the chest was interpreted as showing an increase in the cardiac shadow. Following intravenous therapy the blood pressure rose to 68/58, but soon dropped to 45/20. After two and a half hours' treatment by fluids and stimulants, her condition became progressively worse and a diagnosis of stab wound of the heart with cardiac tamponade was made.

Under nitrous oxide-oxygen positive pressure anesthesia, the chest was opened through a Spangaro incision. A perforation into the chest cavity was found in the fourth interspace about 3 cm. lateral to the sternum. Through the laceration blood spurted with each expiration. On resection of the third and fourth costal cartilages the blood was found to be coming from both ends of a severed internal mammary artery. There was a hematoma in the adjacent tissue. A large dilated pericardial sac bulged into the operative field. Immediately on opening the pericardium the blood pressure rose from 80/50 to 130/90 and remained stable. No injury to the heart was found. The heart was observed for some minutes before closing. The pericardium was approximated without difficulty, leaving a decompression opening into the left chest cavity at one end of the incision. The patient returned to the ward with a blood pressure of 140/80 and a venous pressure 10 cm. of saline. Recovery was uneventful.

The original interpretation of this case was that external pressure from a hematoma was causing the tamponade. On looking back over the experience and in view of these subsequent cases, I do not believe that hematomatous infiltration was responsible. Certainly no sizable quantity of hematoma was evacuated.

It is probable that alcohol and trauma were the major etiologic factors causing dilatation in Cases I and III. In Case II the dilatation followed anoxemia of the cardiac

muscle resulting from the coronary obstruction. Once complete cardiac failure starts, a vicious circle must take place, since the poorer the circulation the less the oxygen supply, and with the anoxemia the heart muscle loses its tone. The limits of dilatation are reached with the limits of elasticity of the pericardial sac. When the heart can no longer dilate, the flow of blood into the heart chambers ceases; since the muscle fibers are no longer on a tension, they lose their contractility and cardiac activity stops.

Beck and Bright<sup>10</sup> tried to produce rupture of the heart in dogs by sudden compression of the abdomen and hind extremities, thus creating a suddenly increased volume in the vascular bed above the diaphragm. They found that in animals with an intact pericardium the heart dilated to a certain maximum regardless of additional increase in compression. The average increase in the transverse cardiac x-ray shadow was 2.3 mm. Another group of experiments was run in which the pericardium had been split from base to apex prior to compression of the abdomen and legs. The average increase in the transverse diameter of the cardiac shadow of this series of animals was 9 mm. In their conclusions and summary, Beck and Bright state, that "the pericardium supports the heart as it dilates in response to this sudden alteration in the circulation, was shown by experiment." Also, "the pericardium may restrict acute dilatation of the heart."

That the pericardium does restrict acute dilatation of the heart, there can be little

doubt. But there can be considerable doubt that this restriction on an acutely failing heart is entirely beneficial, since it is probably another cause of an acute cardiac compression syndrome.

#### SUMMARY

1. Three explored cases of cardiac compression resulting from acute cardiac dilatation are reported.

2. Acute coronary occlusion from ligation of the left coronary artery, with sequence of events is described.

3. A new point in the pathologic physiology of the heart and pericardium during acute cardiac dilatation is presented.

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# ABDOMINAL ACTINOMYCOSIS

## RECOVERY FOLLOWING SURGICAL TREATMENT AND USE OF ZINC PEROXIDE AND SULFANILAMIDE

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THE usual methods of treatment of actinomycosis have included the use of potassium iodide, thymol, x-ray and copper sulfate, and of surgical drainage. Recently, treatment with sulfanilamide has been recommended.<sup>1</sup> In one case we employed not one agent but a combination of several agents: first, adequate surgical drainage, all the sinus tracts being carefully curetted and exposed widely but never beyond the area of induration; second, "effective" zinc peroxide, as advocated by Meleney for retarding the growth of the potentially anaerobic actinomyces, and, third, sulfanilamide.

### CASE REPORT

A man 45 years of age, a butcher, entered the Evanston Hospital on December 26, 1938, with the complaint of a loss of 45 pounds and soreness in the right side of the abdomen for four months, associated with swelling for two weeks. Two years previously he had been treated for dysentery and one year previously for anal fissure. Four months previously hemorrhoids were given injection treatment. He had enjoyed good health until four months prior to admission to the hospital, when soreness in the right side caused considerable discomfort, especially when he was walking or was lying on that side.

Examination revealed that immediately beneath the skin there was a firm, fixed, irregular nodular mass about the size of a grapefruit. This mass was definitely inflammatory in nature and had caused the overlying skin to become reddened and hot. There were no sinuses in the skin. The mass was dull on percussion, did not pulsate and seemed to be located outside the abdominal cavity. Rectally there was found a moderate amount of indura-

tion on the right side. The temperature was 100.4°F., the hemoglobin value 8 Gm. and the red blood cell count 3,600,000. Roentgen study of the gastrointestinal tract disclosed no abnormality.

A preoperative diagnosis of actinomycosis of the abdominal wall, probably originating from the ileocecal region, was made. At operation the diagnosis was confirmed by discovery of ray fungi in the pus on microscopic study. The sinuses were curetted carefully. The cavity was then packed with vaseline gauze, which held several Carrel tubes in place. Through these tubes, solution of zinc peroxide was injected. The dressings were changed daily, and fine-mesh gauze impregnated with zinc oxide ointment was packed into the wound. Through the Carrel tubes zinc peroxide was injected at intervals of two or three hours. On the second day after operation the patient was given four doses each of 20 gr. of sulfanilamide. The treatment was continued for nine days and was stopped because of nausea and vomiting. However, after the patient recovered from this reaction, the drug was again given for a period of four days in the same amounts. Healing of the wound progressed nicely. During the post-operative course pneumaturia developed, and cystoscopic study revealed a 0.6 mm. red edematous area without any demonstrable opening. No evidence of cystitis was found. Culture and smear of the urine showed no evidence of sulfur granules. It was believed that the process was secondary to the actinomycosis. The condition improved without becoming serious.

The abdominal wound was clean and was healing well when the patient was discharged, twenty-seven days after operation. Two months after discharge he was in good health and had returned to work. The wound was practically healed.

We believe that this case illustrates a satisfactory method of treatment of abdominal actinomycosis. The essential factors are: first, the early recognition of the condition and, second, the intensive treatment by means of (a) thorough surgical drainage and curettement; and (b) the

use of zinc peroxide dressings; and (c) sulfanilamide.

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### CORRECTION

Dr. R. J. Behan, author of an article entitled "The Treatment of Suppurative Generalized Peritonitis with Alcohol," which appeared in our October issue, wishes to make a few changes in his statements.

On page 97, the last paragraph, first column, should read: "In this period from 1920 to 1931 we had forty-six cases of

generalized peritonitis, forty-two resulting from appendicitis and four resulting from other causes in which treatment with alcohol was given." In the same paragraph, second line from the top, right hand column, the per cent of mortality should read 5.79 and not 6.15; and on page 98, third line, right hand column, the death rate should be 5.79 instead of 8.69.



[From Fernelius' *Universa Medicina*; Geneva, 1679.]

# BOOKSHELF BROWSING

THE PRACTICE OF OBSTETRICS FIFTY YEARS AGO (1890)

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WHEN The Brooklyn Gynecological Society was formed fifty years ago, there was perhaps some discussion as to whether it should be called gynecologic or obstetric. I do not know. I am certain, however, that Brooklyn gynecologists have always held obstetrics as their major interest. And this is as it should be.

Obstetrics with its roots deep in anatomy and physiology, biology and biochemistry grows at a great pace in our day. There are many living today who have contributed to the development of prenatal care itself, intravenous dextrose therapy, blood transfusion, a more rational approach to the problem of eclampsia, consistent improvement in the technique of cesarean section, accurate pelvic roentgenography and finally our new appreciation of the importance of droplet infection.

Nothing is older than birth. Delivery, whether it was accomplished or managed, has always been a problem; yet no real advance was made from the time of Soranus in the second century until Paré revived podalic version some 1500 years later. There was no textbook in any language for 1400 years. In the sixteenth century the remarkable folklore of the past was copied and printed to serve as a textbook for all the physicians in Europe for another 200 years.

We have no lack of textbooks, but even in 1890 they were few. The English textbook of Playfair and "The Science and Art of Midwifery" by William Thompson Lusk, Professor of Obstetrics and the Diseases of Women and Children in the Bellevue Hospital Medical College were easily the most popular. Lusk's text was used in the Long Island College Hospital, the University of the City of New York, the College of Physicians and Surgeons and the New York Polyclinic as well as in the author's own school. In the edition of 1890, dedicated to Fordyce Barker "In grateful acknowledgment of his generosity toward the younger members of his profession" we should be able to discover the obstetrical teaching of that day.

In the preface we read, "It is with special gratification that I take this opportunity to draw attention to the triumph of the modern doctrines concerning the nature of puerperal fever, and to the wonderful results that have proceeded from the application of Mr. Lister's teachings to the hygiene of lying-in hospitals. The latter have ceased to be pest-houses, and it is now a question whether forlorn women confined in properly conducted maternities, are not actually safer than the fortunate classes in their own homes."



His discussion of the hygiene of pregnancy is good, yet his admonition to wear flannel drawers would hardly meet with feminine approval today. "Since the sobering effect of experience has invariably served to dispel illusive hopes . . . it is usually therefore the part of prudence to do nothing for morning sickness or even continuous nausea, . . . to let the wife go home on a visit to her mother furnishes a serviceable hint in the way of practice." For continued vomiting, he advised that the cervix, if eroded, should be brushed with 10 per cent nitrate of silver, or the faradaic current or an ether spray applied to the pit of the stomach, or an icebag to the cervical vertebrae. W. Gill Wylie, he states, has found that most cases of nausea were cured by opening the cervix with a dilator of his own invention, dusting the cervix with iodoform and applying a glycerin tampon. Dilatation was effected "without much risk" up to the internal os; even when the cervix was so patulous that dilatation seemed useless, stretching of tight bands found well up in the cervix brought prompt relief. Rarely were more than two treatments necessary.

In labor the physician was advised to repeat his vaginal examination at hourly intervals during the first stage and frequently in the second. If rupture of the perineum was felt to be imminent, "mock modesty should be discarded, and the parts imperiled should be unhesitatingly exposed to view . . . the physician is justified in making lateral incisions through the vulva . . . to this operation the term episiotomy is applied, yet it should never be performed so long as hope exists of otherwise preserving the perineum. It is essentially the operation of young practitioners, the occasions for its employment diminishing in frequency with increasing experience." The operation was lateral, done with a bistoury so as to divide the vagina and not the skin. The abdominal binder, he thought, should not be discarded as some had advised, yet to apply it "with address is not an indifferent accomplishment."

Lusk knew only ether and chloroform and advised caution in their use, for "the practice admits neither of ignorance or carelessness. There is no doubt that the vast majority of medical men refrain from the use of anesthetics in ordinary labor, either from vain apprehensions, or because some incident in their practice has led them to suspect that, in spite of statistics, they are not devoid of objectionable or dangerous properties."

"The diagnosis of multiple pregnancy," he writes, "is rarely to be made out with absolute certainty." If delivery of the second child were delayed more than an hour, the membranes should be ruptured, but "In case of a premature child delivered with its own placenta, cases of continued development in utero of the remaining child would point to the policy of abstention."

Breast feeding was advised. "If it is impossible to procure the services of a wet nurse, or if the aversion of the parents to wet nurses as a class proves unconquerable, artificial alimentation must be tried. It is unquestionable that many babies thrive fairly when brought up on the bottle."

In the treatment of hydatidiform mole, after its expulsion or manual removal, the uterus was irrigated or swabbed with perchloride of iron; the Thomas' dull-wire curette was used for persistent hemorrhage. "Its prognosis is not extremely unfavorable in the majority of cases," he writes, and "determined chiefly by the violence and frequency of the attending hemorrhages." In the treatment of abortion, repeated solid and effective packs and manual removal were in general use, with sponge tents, when necessary, for dilatation of the cervix. Lusk liked to use a tolerably firm curette where "owing to inflammatory conditions, I have hesitated to make the circuit of the uterine cavity with my finger."

In 1890, the diagnosis of extrauterine gestation before rupture was rarely made; death often occurred without the slightest suspicion as to the nature of the case. We read: "The indication for treatment in the early months is plainly the adoption of

measures to destroy the life of the fetus, and thus by arresting the growth of the ovum, avert the danger of rupture and hemorrhage. . . . Spontaneous recovery commonly follows the death of the embryo." Puncture of the sac through vagina or rectum, or injection of morphin or atropin into it were in common use. T. Gaillard Thomas had opened the sac with the thermocautery and the patient narrowly escaped with her life. Lusk thought that daily use of the faradaic current, with one pole in the rectum or vagina and the other over Poupart's ligament was safe and efficient. This treatment was popularized by Thomas who saw most of the cases in New York in consultation. He was aware of Lawson Tait's success with laparotomy, but apparently had no experience with it. At operation it was advised, when the peritoneum was reached, that a small nick be made first and a small pipette introduced for verification of the diagnosis. He writes, "Strange to say, but two operators in these days of abdominal surgery have had the hardihood to carry these (instructions) into execution. The reasons for this backwardness are probably to be found in the uncertainties of the diagnosis, the risk of finding the sac hopelessly matted to the adjacent viscera, the dislike of operating upon a dying woman, and the fact that a considerable number of spontaneous recoveries occur." Playfair thought it "A bold and heroic procedure, not hopeless, since the alternative is death."

Because of its hazards, cesarean section was "chiefly justifiable in cases in which craniotomy and the delivery of the child through the natural passages involve the life of the mother in still greater peril. It is indicated, therefore, in extreme pelvic contraction, in the case of solid tumors which encroach upon the pelvic space and in advanced carcinomatous degeneration of the cervix."

The operating room should be thoroughly aired and disinfected by burning sulfur and "a convenient operating table can be readily improvised by covering an ironing table

with blankets or an old-fashioned comforter." The intestines were outlined by percussion and pushed to one side out of harm's way. An assistant, whose principal function was to guard against protrusion of the intestines, steadied the uterus in the midline as the incision was made; when the uterus was exposed, he redoubled his vigilance, compressing the uterus firmly against the incision, dextrously hooking his index fingers into the angle of the incision and lifting the uterus into close contact with the abdominal wall to prevent escape of amniotic fluid into the peritoneal cavity. The incision was then enlarged with a bistoury and "the membranes ruptured through the wound, rather than through the vagina; it is more quickly effected, and time at this stage is precious . . . even where, at the conclusion of the operation, the uterus is well retracted and the hemorrhage arrested, it is well to still use the sutures as a prophylactic against secondary hemorrhage." Some operators were content with friction and the use of ice, but Lusk used carbolyzed silk sutures since catgut had been found impracticable; the knots loosened with postpartum contractions of the uterus.

"It is obvious," says Lusk, "that the classical cesarean section, even with the addition of the suture and the employment of strict antisepsis, is still far from answering the requirements of a conservative procedure," since separation of the uterine wound occurred in spite of the suture. He knew that Kehrer had, in 1882, opened the uterus through a transverse incision in the lower segment, separating the peritoneum so as to cover his muscle sutures with it. The cesarean operation in this country was formidable with about 60 per cent mortality. The results of laparo- or gastro-elytrotomy, the extraperitoneal operation devised by Thomas, and successfully performed by Skene and Jewett in 1885 were such "as to inspire a confidence in its feasibility" at least equal to that employed by the rival procedure of Porro.

Lusk's attitude toward induction of labor when eclampsia threatened was no different

from ours, yet he said that the weight of authority was for procrastination, "the interruption of pregnancy being regarded an extreme measure, justifiable only in cases of utmost peril." He advised phlebotomy of eight to sixteen ounces as the first step in the treatment of convulsions.

Most authorities advised expectancy in the treatment of the hemorrhages late in pregnancy, except when the loss of blood was alarming, but Lusk taught that there was no safety as long as pregnancy continued and advised Braxton-Hicks version or a bag.

"The treatment of postpartum hemorrhage," he said, "is one of the most satisfactory departments of obstetrical practice." Transfusion is theoretically rational.

"In practice, however, the difficulties of the technique, the hesitation of the bystanders to furnish the required blood, combined with the somewhat unsatisfactory results of transfusion are all obstacles to its employment. For a long time I carried with me Aveling's very simple and ingenious transfusion apparatus. In the few cases where I had intended to use it, however, the tubing was never in perfect order. Pro-

fessor Gaillard Thomas recommends the substitution of the intravenous injection of milk for that of blood" as a perfectly feasible, safe and legitimate procedure. "None but milk removed from a healthy cow within a few minutes of the injection should be employed. Decomposed milk is poisonous and should no more be used than decomposed blood. The intravenous injection of milk is infinitely easier than the transfusion of blood . . . and like that of blood is commonly followed by a chill, and rapid and marked rise of temperature; then all subsides, and great improvement shows itself in the patient's condition. Not more than eight ounces of milk should be injected at one operation." Playfair advised the use of defibrinated blood, but said that there were no encouraging statistics and that transfusion should be done only when life was on the verge of extinction.

It is good for us to review the errors of the past, not for the cultural value alone, but to remind us that we, too, may be just as far from the truth. I venture to say that the gap between our knowledge and the future is far greater than that which separates us from all the past.



SPECIAL MONOGRAPH

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# Diagnosis and Treatment of Various Types of Diaphragmatic Hernia

BY

STUART W. HARRINGTON, M.D.



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# DIAGNOSIS AND TREATMENT OF VARIOUS TYPES OF DIAPHRAGMATIC HERNIA\*

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THE most common lesions of the diaphragm which require surgical treatment are abnormal openings through its structure which permit herniation of the abdominal viscera into the thoracic cavity. These abnormal openings may be attributable to congenital structural deficiencies of the diaphragm and occasionally of the esophagus, or they may be caused by traumatic rupture or inflammatory necrosis of the normal diaphragm.

The subject of the diagnosis and treatment of diaphragmatic hernia has received more consideration in recent years because its more frequent recognition has changed its status from that of a rare condition to one that is not infrequently encountered. However, I believe that this subject deserves more general interest and consideration than it is accorded at present, since in many instances the diagnosis is not made until complications have occurred. This subject is of interest to the clinician because the diagnosis is of first importance, the symptoms are often complex and the condition frequently must be considered in the differential diagnosis of diseases of the upper part of the abdomen and lower part of the thorax. It is of interest to the roentgenologist because the roentgenologic recognition of diaphragmatic hernia is often the only means by which a definite diagnosis can be established clinically. The treatment is of primary concern to the surgeon because operative replacement of the herniated viscera, and repair of the abnormal opening in the diaphragm are the only treatments that promise complete relief of symptoms to the patient.

## EMBRYOLOGIC ASPECTS

The formation of the diaphragm from embryonic structures is a highly complex process, because its muscular elements are derived from several sources.

The anterior, lateral and central parts, which comprise the greater portion of the diaphragm in the adult person, are formed from the transverse septum and fused ventral mesentery. The

\* From the Division of Surgery, The Mayo Clinic.



remaining posterolateral portion is formed by the fusion of the dorsal mesentery and the mesoderm derived from the receding wolffian body and the pleuroperitoneal membrane derived from the pulmonary ridge. It is difficult to determine the exact amount of the muscle tissue that is derived from each of these structures, since there is probably considerable variation, but it is probable that the dorsal mesentery forms the posterior and central portions containing the esophageal opening. The mesodermic cells from the receding Wolffian body form the right and left crura. The pleuroperitoneal membrane grows ventrally and closes the remaining opening (hiatus pleuroperitonealis) between the peritoneal celom and the pleural celom, by fusing with the transverse septum, and forms the lateral portion of the diaphragm. Failure of fusion or proper deposition of the mesoderm at any one of these adjacent points of union may result in congenital continuity of the pleural and peritoneal cavities or a congenitally weak portion in the diaphragm at any of these points. Consequently, from an embryologic standpoint, weak portions might be expected to appear at the point of fusion of these different structures. These portions are situated dorsolaterally at the fissura pleuroperitonealis (foramen of Bochdalek); also through the outer crus and through the esophageal opening. Hernia through the dome is common but cannot be explained on the foregoing basis, because it is not a fusion region. Such a hernia may be the result of excessive degeneration of the muscle in the formation of the central tendon or of some pathologic condition. Unilateral absence of the diaphragm probably is the result of the failure of development of the pleuroperitoneal membrane, which usually is found as a narrow ridge of tissue along the posterior wall of the thorax.

*Congenital or Embryologic Aspects of Nontraumatic Hernias and Diaphragmatic Defects.* Diaphragmatic congenital defects and nontraumatic hernias are variously reported as being from ten to eighteen times as frequent on the left side. The cause undoubtedly is to be found in the embryonic formation of the diaphragm. This point is a subject of controversy among embryologists. I have attempted to show the different stages in the formation of the diaphragm in embryos of various sizes; but in order to arrive at any satisfactory conclusions as to why hernia is more likely to occur in these regions, one must not only follow the concomitant changes that are occurring in the developing embryo, but must also consider the

physiologic manifestations which are present in the constantly changing organism at the same time.

The septum transversum, from which the anterolateral portion of the diaphragm of the adult person is formed, arises from the mesoderm in the upper part of the cervical region. Its descent is gradual in the early embryonic weeks, and at the 5 to 6 mm. stage it is opposite the fourth and fifth cervical segments, where it receives its innervation from the branches of the third, fourth and fifth cervical nerve roots to these segments (the phrenic nerve). At approximately the same period as that in which the septum transversum appears (2 to 3 mm.), the tracheal bud appears from the ventral surface of the esophagus, and the liver buds have grown vertically into the under surface of this descending septum. The anlage of the stomach also has appeared as a definite thickening of the foregut opposite the fourth cervical segment.

Three important developmental processes occur in embryos of the 5 mm. stage. The pulmonary ridge appears as a definite shelf of mesodermal tissue which forms the pleuropericardial and pleuroperitoneal membranes. The former closes off the pericardial cavity from the pleural cavity at about the 10 to 11 mm. stage, and does not enter into the formation of the diaphragm. The latter ultimately will help to fill in the posterolateral portion of the diaphragm. At this stage (5 mm.) the pleuroperitoneal membrane is only a narrow shelf of mesodermal tissue that projects into the celom, marking the caudal dividing line of the pleural and peritoneal cavities, which are at this stage in free communication with each other.

The second noteworthy change is the unsymmetric development of the right and left pulmonary buds, which are at a slightly lower level than the septum transversum. The right bud grows caudally and posteriorly and an infracardiac bronchus soon develops. The left bud grows almost transversely to the vertical plane and, because of the presence of the left enlargement of the heart, an infracardiac bronchus does not develop. This process places the left lung at a somewhat higher level than the right lung.

The third change occurring at this period is the increased activity in the development of the midgut, which previous to this period has been practically a straight tube. It begins to elongate, with an angulation toward the umbilicus from a cephalic and caudal limb of this portion of the intestinal tract.

From the foregoing it is seen that at this early period of the embryo, the cavity of the body is beginning to divide into two main cavities, the peritoneal cavity and the pleural cavity, by an incomplete shelf of fetal muscular tissue derived from several sources. Ventrolaterally, this shelf is called the "transverse septum"; dorsally, the less well developed mesodermal shelf is called the "pleuroperitoneal membrane." The intestinal tract with its dorsal mesentery and the Wolffian body extends into the celom in a dorsomesial position. At this stage, there is free communication between the two cavities; this opening may be termed the "pleuroperitoneal hiatus."

In the 7 mm. embryo, the transverse septum with the pleuroperitoneal membrane begins to migrate caudally, rapidly passing the pulmonary buds and the anlage of the stomach, placing the greater portion of the lung in the pleural cavity and the anlage of the stomach partially above the diaphragm.

In the 9.4 mm. embryo, the liver has become firmly anchored to the right dorsal wall of the body of the plica vena cava. The midgut begins to grow more rapidly and the yolk sac disappears. This action frees the intestine from the umbilicus, and rotation of this segment of bowel begins.

In the 11 mm. embryo, the stomach, which has been practically stationary, now follows rapidly behind the descending septum transversum, and in the 17 mm. embryo it has virtually reached its permanent position. This descent is made possible by the sudden elongation of the esophagus. During this descent the right and left dorsopleural recesses are converted into bursae which surround the cardia. The left bursa usually disappears, and the right bursa, when well developed, is known as the "infracardiac bursa" and bears a definite relationship to esophageal hernia. At about this period (11 mm.) a physiologic alteration in the abdominal region takes place. The celom has not increased in size enough to accommodate the rapid changes that are taking place within its walls and which are augmented by the descent of the septum. As Mall stated, "Since the liver grows downward and crowds upon the rapidly elongating intestine, the intestine must escape it if it has a chance and the coelomic space within the umbilical cord naturally receives it." This phenomenon, known as "physiologic umbilical herniation," provides a reservoir for the abdominal contents until the peritoneal cavity has grown sufficiently to store its own contents. The herniated

intestine is restored to the abdominal cavity by the growth of the abdominal wall past the fixed mesentery of the intestines. This physiologic herniation starts in the 11 mm. embryo, is well developed in the 22 mm. embryo and starts on its way toward voluntary reduction in about the 35 mm. embryo.

During this period of greater activity in the abdominal celom, the diaphragm is incompletely formed, and the hiatus pleuroperitonealis is patent. The closure takes place on the right side first in about the 17 or 18 mm. embryo and on the left side in about the 19 or 20 mm. embryo. The left side of the liver has largely disappeared, and the whole organ has rotated to the right and fused with the right wall of the body, protecting to a great extent the right half of the diaphragm and probably aiding its most rapid completion. The stomach has reached its permanent site below the diaphragm before the left half of the diaphragm is closed. Therefore, the hiatus pleuroperitonealis patent on the left side is in direct contact with the rapidly forming and constantly changing hollow viscera during this period of physiologic umbilical herniation.

It would seem that this time of the incomplete closure of the diaphragm in relationship to multiple rapid changes which are taking place in the embryo is of great importance in the preponderance of left-sided congenital defects. To recapitulate, these changes consist of: (1) the occurrence at this time of the normal physiologic umbilical herniation; (2) the patency of the hiatuses connecting the peritoneal and pleural cavities; (3) the sudden descent of the diaphragm, which is considerably in advance of the descent of the stomach; (4) the shift of the liver to the right because of anchorage and the degeneration of the left lobe from vascular change and pressure; (5) the presence of hollow mobile viscera on the left side; (6) the elevated position and smaller size of the left lung; (7) the rotation of the stomach to the left, and (8) the presence of bursae at the esophageal opening.

On the basis of the foregoing material it is seen that embryonic herniation would occur most commonly in the 11 to 20 mm. embryo. Congenital herniation of somewhat later formation can be explained on many of the same grounds. It is the result of failure of parts of the diaphragm to mature, or of excessive degeneration of muscular elements in the formation of the central tendon.

Inasmuch as the stomach descends behind the septum transversum, if there is a delay in descent of the stomach, the lumbar

portion of the diaphragm will be imperfectly developed, and the esophageal hiatus will be formed around the cardiac end of the stomach instead of around the esophagus. This will result in an abnormally large hiatus with deficiency both in the muscle ring and in the attachments of the diaphragmatico-esophageal membrane. The degree of the deficiency depends on the amount of gastric anlage in the thorax at the time of muscularization of the lumbar portion of the diaphragm. In rare instances the stomach may remain in the elevated position as a result of a congenitally short esophagus and a partial thoracic stomach will result. In most instances the esophagus continues to elongate normally, thus placing the stomach below the diaphragm. This abnormal position of the stomach will cause an abnormal enlargement of the esophageal hiatus to be produced, with a wide space between the margin of the muscle and the wall of the esophagus. It will also result in imperfect fixation of the elastic membrane to the esophagus and stomach and an abnormally large peritoneal fold extending well down on the cardia of the stomach. This abnormal relationship will permit much more flexibility of the esophagus in the enlarged hiatus than is normal. The more defective the formation of the hiatus, the more likely is herniation of the stomach to occur through it in later life. The true congenital hernia present at birth may be explained in the same way, but it is probable that persistence of the dorsopleural recess may be a factor in the origin of congenital hernias.

#### ANATOMIC ASPECTS

The diaphragm is a single, independent, dome-shaped muscle arising from the circumference of the lower part of the thorax and which, when it is normally formed, completely separates the abdominal and thoracic cavities. (Fig. 1.) The muscular structure of the diaphragm in the adult person is divided into three portions according to the origins of these portions: the sternal, costal and lumbar portions. The sternal is the weakest of these portions and the lumbar is the strongest. All three portions are inserted into the margin of a central tendon. The sternal portion consists of a few slender fasciculi arising from the posterior surface of the xyphoid cartilage. There are muscular deficiencies on each side of the cartilage filled with areolar tissue and covered with pleura and peritoneum through which the superior deep epigastric vessels pass. These deficiencies are called the foramina of Morgagni or Larrey's spaces.

The costal portion forms the main part of the dome of the diaphragm and arises by broad bands of muscle from the lower six costal cartilages and from the eleventh and twelfth ribs, interdigitating

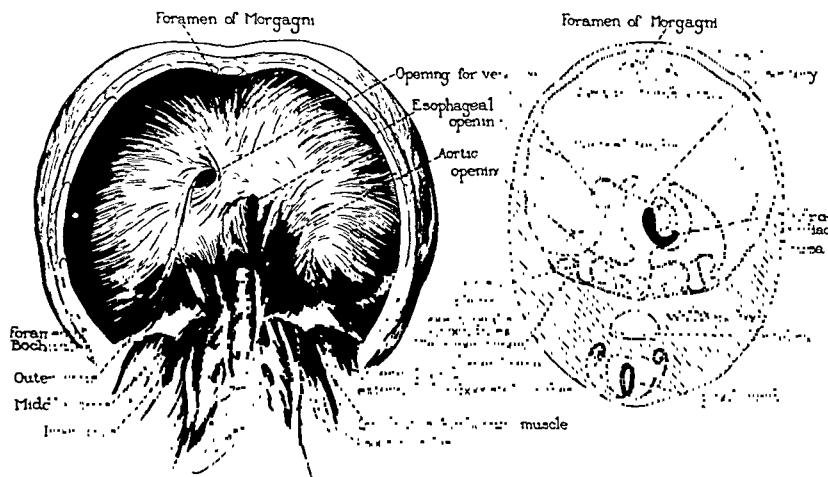


FIG. 1. Left, adult diaphragm viewed from below; normal openings and potential sites of herniation. Right, semidiagrammatic reconstruction of embryonic (17 mm.) diaphragm showing the embryonic structures concerned in the formation of the adult diaphragm and the sites for possible congenital deficiencies. This diaphragm shows the hiatus pleuroperitonealis patent on both sides at this stage. The space enclosed by the dotted lines indicates the extent of this opening at the 11 mm. stage. The infracardiac bursa, the potential site of herniation around the esophagus, is also shown. (*Arch. Surg.*, 16: 386, 1928.)

with the transversalis muscles. This portion covers the greatest area. There often are areas devoid of muscular tissue situated between the individual bands that arise from the wall of the thorax.

The lumbar portion arises from the bodies of the lumbar vertebrae and consists of three crura on each side: the inner, middle and outer crura. The inner crus is much the strongest of the group, and arises from the anterior surface of the third and fourth lumbar vertebrae. The greater portion of the inner crus is muscular, but the inner margins soon become tendinous and unite at the level of the twelfth thoracic vertebra. This arch, with the bodies of the twelfth thoracic and first lumbar vertebrae, forms a canal for the passage of the aorta and thoracic duct. This is called the aortic opening; it is in reality not an opening through the diaphragm, but is situated entirely behind the diaphragm. The esophageal opening is anterior to, and a little to the left of, the aortic opening. It is entirely surrounded by muscular tissue and is formed by the decussation of the

crura on a level with the tenth thoracic vertebra. It transmits the esophagus and its vessels and the two vagi nerves. The middle crus arises from the lateral surfaces of the body of the second lumbar vertebra; it is separated posteriorly from the inner crus by narrow slits which transmit the greater and lesser splanchnic nerves of each side, and the left crus transmits the vena azygos minor. The vena azygos major transverses either the aortic opening or the right crus. The outer crus arises from the internal and external lumbocostal arches (arches of Haller) which arch over the psoas and quadratus lumborum muscles posteriorly.

The lateral lumbar portion of the diaphragm arises chiefly from the inner lumbocostal arch, with only a few fibers arising from the external lumbocostal arch. There is usually a triangular-shaped space of muscular deficiency between the outer crus of the lumbar portion of the diaphragm, the last muscular part of the costal portion of the diaphragm, and the twelfth rib. The apex of the triangle is curved upward and forward toward the tendinous portion of the diaphragm. The base is turned downward and somewhat backward and partly rests on the twelfth rib, but sometimes it extends in front of the body of the psoas muscle. The borders of this hiatus are muscular and are more or less of sphincter-like construction. The space is closed by a membrane which consists of two sheaths; the upper sheath comes from the pleura, and the lower sheath is thin and is a continuation of the iliac fascia. This space was first described by Bochdalek, in 1848, and has been named the "foramen of Bochdalek."

The central tendon of the diaphragm is reniform, with the central portion slightly curved and extending into the dome, of which the greater portion is on the right side. At the base of this right portion and entirely within the tendon is a large quadrilateral foramen which gives passage to the inferior vena cava. This opening is on a level with the disk between the eighth and ninth thoracic vertebrae.

The diaphragm receives its motor innervation from the phrenic nerve, which originates from the fourth and sometimes through branches from the third and fifth cervical nerves. This cervical origin of the innervation of the diaphragm is due to the embryonic derivation of the diaphragm from cervical myotomes which are innervated by the third, fourth and fifth cervical nerves. These nerves originally may have contained both motor and sensory fibers but most anatomists agree that the phrenic is the chief, if not the only, motor nerve to the diaphragm. The presence of some afferent

sensory nerve fibers in the phrenic nerve will explain the presence of referred pain in the neck which is often associated with disorders of the diaphragm. Some anatomists are of the opinion that the

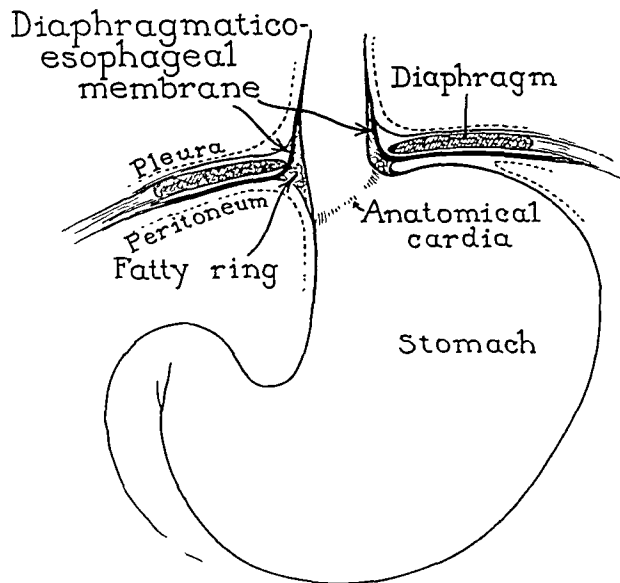


FIG. 2. Normal anatomic relationship between lower end of esophagus, cardiac end of stomach and esophageal hiatus, showing the relationship of the diaphragmatico-esophageal membrane to these structures. (*J. Thoracic Surg.*, 8: 127, 1938.)

peripheral part of the diaphragm receives some motor innervation from the lower intercostal nerves.

The circular muscle bundles of the esophageal hiatus are innervated chiefly by the phrenic nerve of the same side, regardless of whether the muscles originate from the crus of the same side or from that of the opposite side. There also may be some cross innervation from the phrenic nerve on the opposite side.

In considering the normal relationship between the esophageal hiatus and the lower end of the esophagus and cardia, I wish to mention again the fact that the esophageal hiatus is normally situated to the left of the medial line, at the level of the upper border of the tenth thoracic vertebra, in the dorsal part of the dome of the diaphragm.

The muscular elements that form the muscular ring of the hiatus usually originate from the median portion of the right crus, but the hiatus may be formed by the crossing of both right and left crura



after they have united in front of the aorta to form the aortic orifice. This ring of muscle of the hiatus loosely approximates the lower end of the esophagus but is not directly attached to it. Fixa-



FIG. 3. *a*, dissection of normal attachment of the diaphragmatico-esophageal membrane (held in the clamp). Fascia covering space to right is a persistent infracardiac bursa. *b*, same as *a*, after removal of peritoneum and anterior attachments of diaphragmatico-esophageal ligament showing posterior attachment of this ligament extending beneath and not attached to the circular muscle of the hiatus.

tion of the diaphragm to the lower end of the esophagus and to the cardia of the stomach is obtained by the diaphragmatico-esophageal membrane. (Fig. 2.) This membrane consists of elastic and fibrous tissue originating in the fascial coverings of the diaphragm; mostly those of the abdominal side but partly those of the thoracic side of the diaphragm. (Figs. 3 and 4.) This elastic and fibrous membrane has its origin lateral to the muscular ring of the hiatus over which it passes, with slight attachments, to fill the space between the inner margin of the muscle and the esophagus; it is inserted into the lower 2 or 3 cm. of the esophagus and into the upper 1.5 to 2 cm. of the stomach, in a fanlike manner. This elastic and fibrous membrane constitutes a flexible connection between the diaphragm, esophagus, and cardia, and permits of a certain amount of mobility during the act of swallowing and during respiratory movements. (Fig. 5.) Its greatest strength is in its esophageal attachment, where it acts as an antagonist to the longitudinal muscle fibers of the esophagus, preventing these muscles from pulling the cardia of the stomach through the hiatus. The lower part of the esophagus passes obliquely through the diaphragm and extends below the hiatus for a varying distance of from 0.5 to 1.5 cm., where it joins the stomach at an angle. This junction is the true cardia and normally is always situated below the diaphragm.

The normal peritoneal covering and attachments of the esophagus and cardia of the stomach, around the esophageal hiatus, are of great importance. The abdominal portion of the esophagus is loosely



FIG. 4. Photomicrograph of normal diaphragmatico-esophageal ligament removed from previous specimen (Fig. 3*b*), especially stained to show elastic tissue (constituting approximately 50 per cent of the ligament) in regular curved bands between bands of connective tissue.



FIG. 5. Showing normal flexibility of the diaphragmatic movements due to the elasticity and flexibility of the attachments of the diaphragmatico-esophageal membrane to the esophagus and stomach: *a*, diaphragm in midposition; *b*, diaphragm in extreme descent; *c*, marked elevation of diaphragm.

covered with peritoneum on its anterior and left aspects. (Fig. 6.) The uppermost part of the stomach is loosely covered, for about 2 cm. anteriorly and 3 cm. posteriorly, where the peritoneum fuses with the serous covering of the gastric wall. The union of these two folds of peritoneum forms the gastrophrenic ligament which fixes



FIG. 6. Showing normal relationship of the peritoneal and subperitoneal fatty pad to the lower part of the esophagus and to the cardia of the stomach: *a*, shows the normal redundancy of the peritoneum; *b*, shows the diaphragmaticogastric attachments of the peritoneum to the cardia and fundus of the stomach; *c*, after removal of the gastric attachment of the peritoneum to the stomach showing 2 to 3 cm. of the esophagus which is normally below the diaphragm.



FIG. 7. Roentgenogram on admission of patient showing esophageal hiatus diaphragmatic hernia with herniation of approximately a fourth of the stomach above the diaphragm. Patient aged 65 years; progressive symptoms of four years' duration.

the cardiac end of the stomach to the diaphragm and continues to the left to form the phrenicocolic ligament. Beneath this loose peritoneal covering there is a triangular pad of fat and connective

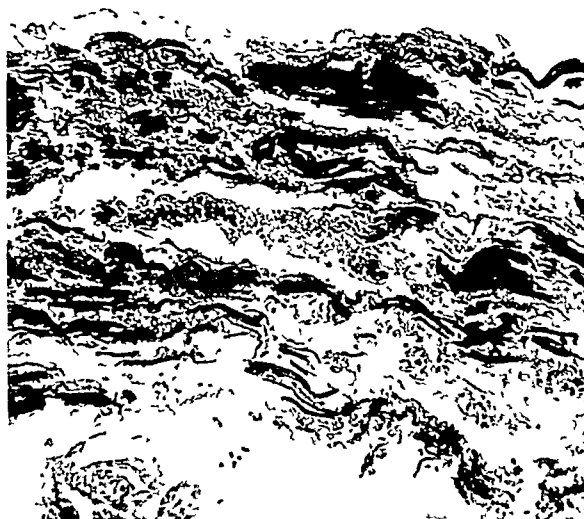


FIG. 8. Same patient as in Figure 7. Photomicrograph of a portion of the diaphragmatico-esophageal membrane which was removed at the time of the operative repair of the hernia, especially stained to show elastic tissue. Atrophy of the elastic tissue bands is evident. (Compare with normal shown in Figure 4.)

tissue and the attachments of the diaphragmatico-esophageal membrane. This loose peritoneal attachment around the esophageal hiatus permits flexible movement of the esophagus without pulling on the peritoneum.

*Anatomic Aspects of Hiatus Hernia.* At this point, a digression may be made to consider the anatomic factors involved in hiatus hernias. The diaphragmatico-esophageal membrane and the loose attachment of the peritoneum at the cardia have considerable bearing on the occurrence of hiatus hernias. It is probable that the hiatus hernias of elderly people, which are accompanied by insufficiency of the hiatus, are attributable to atrophy of this protective elastic membrane, particularly in cases in which there is an abnormally large hiatus. (Figs. 7 and 8.) The elastic membrane has been sufficient during the prime of life to protect the opening but, as the atrophy associated with advancing years develops, the stomach is permitted to protrude through the large hiatus to a position above

the diaphragm. It is probable, in such cases, that this herniation would have occurred earlier in life had abnormal stress been applied, such as trauma, respiratory difficulty or marked increase in intra-

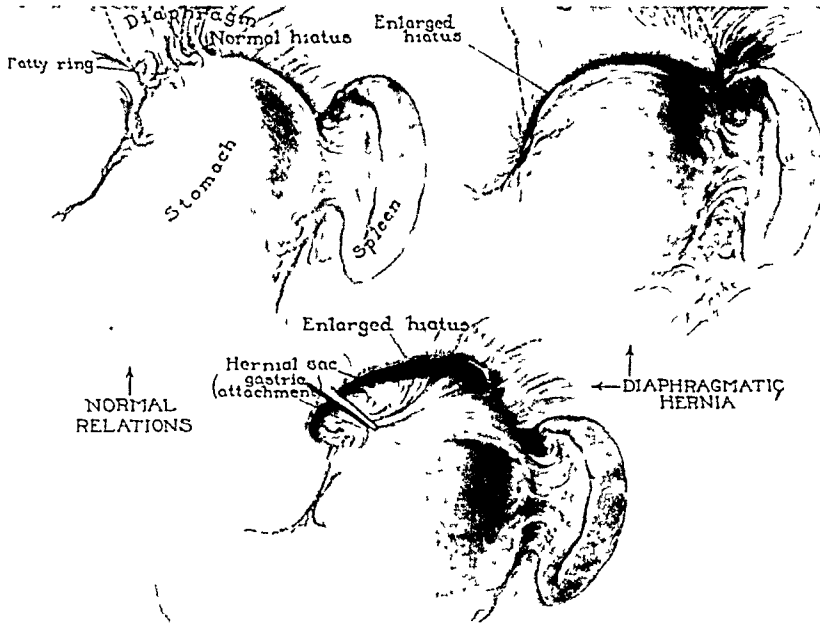


FIG. 9. The anatomic relationships at the cardia of a normal stomach compared to those associated with esophageal hiatus diaphragmatic hernia. These relationships in the latter are shown with the herniated portion of the stomach in the hernial sac and after it has been withdrawn.

abdominal pressure. The elastic and fibrous membrane forms one of the coverings of the hernial sac in the smaller types of hernia. In large hernias this membrane seems to be pushed forward and there is no barrier to the peritoneal sac which enters the posterior portion of the mediastinum. In these cases the entire stomach often herniates into the thorax.

The loose attachment of the peritoneum around the hiatus may be a factor in the formation of hiatus hernias, since it permits the beginning of the herniation of the cardiac end of the stomach and formation of the hernial sac.

In all true hernias this loose peritoneal fold fuses with the serosa farther down on the cardia of the stomach than normal. (Fig. 9.) The peritoneum does not extend around the greater curvature of the stomach to the posterior wall to form the gastrophrenic ligament, but fuses with the serosa of the anterior wall, so that there is no

gastrophrenic ligament and only a very short phrenicolienal ligament. This places the spleen close to the left margin of the hiatus, thus permitting the upper part of the cardiac end of the stomach to be abnormally free posteriorly, beneath the enlarged esophageal hiatus.

The consistency with which the surgeon finds abnormal attachments of the peritoneal fold and of the gastrophrenic ligament to the cardiac end of the stomach, and abnormal enlargement of the muscular ring of the esophageal hiatus, suggests that this particular type of hernia results from a delay in descent of the esophagus as related to the formation of the lumbar portion of the diaphragm.

#### CLASSIFICATION OF DIAPHRAGMATIC HERNIA

The term, "diaphragmatic hernia," is commonly used to designate any condition in which there is protrusion of abdominal contents into the thoracic cavity through an abnormal opening in the diaphragm. All true hernias have a sac as one of their component parts, so that many conditions, commonly included under this term but which do not have hernial sacs, would more properly be termed "eviscerations" or "false hernias." The presence or absence of a hernial sac cannot be determined by clinical examination. It can be found only at operation.

There are numerous classifications of diaphragmatic hernia which are based on the embryologic and etiologic aspects, pathologic anatomy, the site of the opening in the diaphragm, the presence or absence of a sac, the content of the hernia and other factors. It is difficult or impossible to make most of these classifications clinically; accordingly, many of them are of little practical value. Diaphragmatic hernias are therefore usually classified in three main groups: (1) congenital, (2) acquired and (3) traumatic.

From a clinical and surgical standpoint, the history of a preceding injury is helpful in establishing the diagnosis and in determining the type, urgency and prognosis of the operative treatment. Because of the practical clinical and surgical significance of trauma as an etiologic factor, I have suggested that diaphragmatic hernia be classified into two main groups: nontraumatic and traumatic. I have subdivided these two groups according to the various types.

*Nontraumatic Hernia.* A nontraumatic diaphragmatic hernia may be congenital or acquired. If it is congenital, the hernia is

attributable to embryologic deficiency and usually does not have a hernial sac. The most common sites of a congenital hernia, in the probable order of frequency of occurrence, are: (1) through the hiatus pleuroperitonealis (foramen of Bochdalek), (2) through the esophageal hiatus, (3) through an anterior substernal opening (foramen of Morgagni) (Larrey's spaces), and (4) through the gap left by partial absence of the diaphragm, a gap which is usually situated in the posterior portion of the muscle.

If the hernia is acquired after birth, the sites of occurrence are: (1) through the esophageal hiatus, a type which has a hernial sac, (2) through the region of fusion of the anlage of the diaphragm, and (3) at sites named under the congenital type in the foregoing paragraph.

*Traumatic Hernia.* Traumatic diaphragmatic hernia may be caused by direct or indirect injury, or by inflammatory necrosis of the diaphragm. In case of indirect injury of the diaphragm, the hernia may occur at any point, including points of embryologic fusion; but the most common sites are the dome and posterior half of the left part of the diaphragm. On the other hand, the injury may occur in the right part of the diaphragm. It usually is the result of a severe, crushing injury. When the hernia occurs through the esophageal opening there is a sac, but when it occurs through the leaf of the diaphragm there usually is no sac. In case of direct injury of the diaphragm, the hernia may occur at any point and is usually the result of penetrating wounds, such as those inflicted by a gun or knife.

Rupture of the diaphragm may be the result of inflammatory necrosis which, in turn, has been caused by subdiaphragmatic abscess, or, again, rupture may follow necrosis caused by drainage tubes which have been introduced into empyematic cavities. In these cases the opening usually is situated in the posterior part of the diaphragm and there is no hernial sac.

In general, the various types of diaphragmatic hernia can be divided clinically into two main classes, depending on the abdominal viscera which are involved. In the first class the stomach is the only abdominal viscus incorporated in the hernia; the hernia usually occurs through the esophageal hiatus. In the second class, the intestines with or without the stomach and other abdominal viscera are included in the hernia. Such a hernia usually is of traumatic origin and is caused by laceration of a normal diaphragm. It also

may be of congenital origin and may result from structural deficiency of the diaphragm.

Esophageal hiatus hernia is the most common kind of herniation

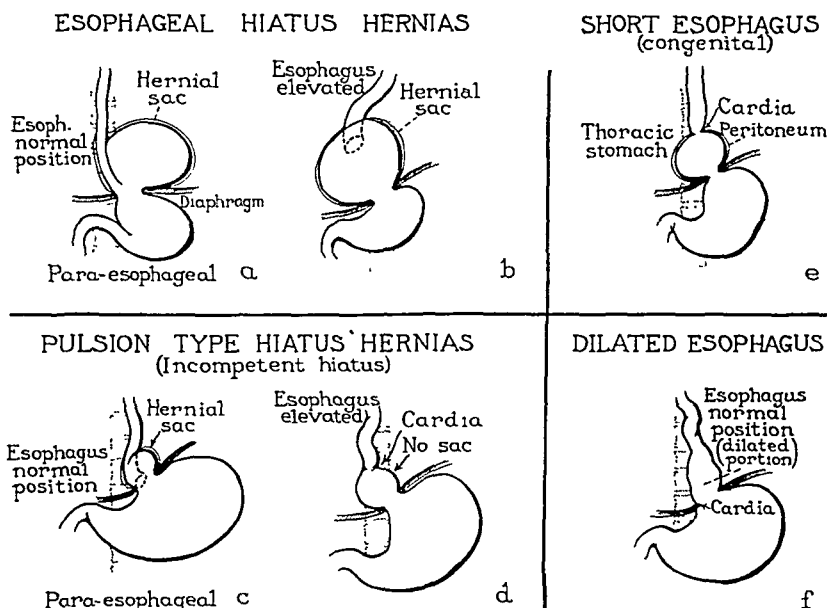


FIG. 10. Diagrammatic drawings of different types of esophageal hiatus hernia and some of the conditions which may simulate hiatus hernias roentgenologically. *a*, esophageal hiatus hernia with herniation of the cardiac end of the stomach through the esophageal hiatus. Esophagus in normal position (para-esophageal hernia). *b*, esophageal hiatus hernia in which there is herniation of the greater portion of the stomach through an enlarged esophageal hiatus and associated elevation of the esophagus. *c*, slight protrusion of the cardia of the stomach through the hiatus with slight elevation of the lower part of the esophagus to the upper margin of the esophageal hiatus. *d*, protrusion of cardiac end of the stomach through the esophageal hiatus and marked elevation of the esophagus into the posterior mediastinum. *e*, congenital, short esophagus with partial thoracic stomach. Not a true hernia. *f*, dilatation of the lower end of the esophagus, cardiac antrum. Not a hiatus hernia.

occurring through the diaphragm that is found among adult persons. This type of hernia is slowly progressive and constitutes a sliding herniation of the stomach into the posterior part of the mediastinum. It may push into either or both sides of the thoracic cavity, but does not enter the pleural cavity. The stomach usually is the only abdominal viscus involved in the hernia. This type of hernia may progress until the entire stomach is contained within the hernial



sac, and the colon, omentum, and occasionally the spleen may also be drawn into the hernial sac.

I believe it is best to classify all true hernias through the esopha-



FIG. 11. *a*, patient aged 52 years. Hiatus hernia (para-esophageal) with herniation of cardiac half of the stomach above diaphragm. Esophagus compressed, normal length. *b*, same patient after repair of hernia. Stomach in normal position below diaphragm.

geal hiatus under the one term "esophageal hiatus diaphragmatic hernia." (Fig. 10.) True esophageal hiatus hernias can be divided into two types: In the first type of esophageal hiatus hernia (Fig. 10*a*) the esophagus is of normal length and its lower end is not elevated above the diaphragm, but a portion of the stomach has herniated into the posterior mediastinum, beside the esophagus. This type of hernia is often designated as para-esophageal hiatus hernia. The hernias are usually small to moderate in size and rarely involve more than a fourth to a half of the cardiac end of the stomach, which is contained in the hernial sac. They constitute about a third of the esophageal hiatus hernias on which I have operated. (Figs. 11 and 12.)

In the second type of hiatus hernia (Fig. 10*b*) the esophagus is of normal length but its lower end is elevated above the level of the diaphragm, and the herniated stomach is in the posterior mediastinum. The hernias are usually larger than those of the first type and a third of the stomach or the entire stomach, with a portion of the omentum and occasionally a portion of the colon, is within the

hernial sac. These hernias usually fill the entire mediastinum and generally project into the left side of the thoracic cavity but they may project into the right side of the thoracic cavity or into both

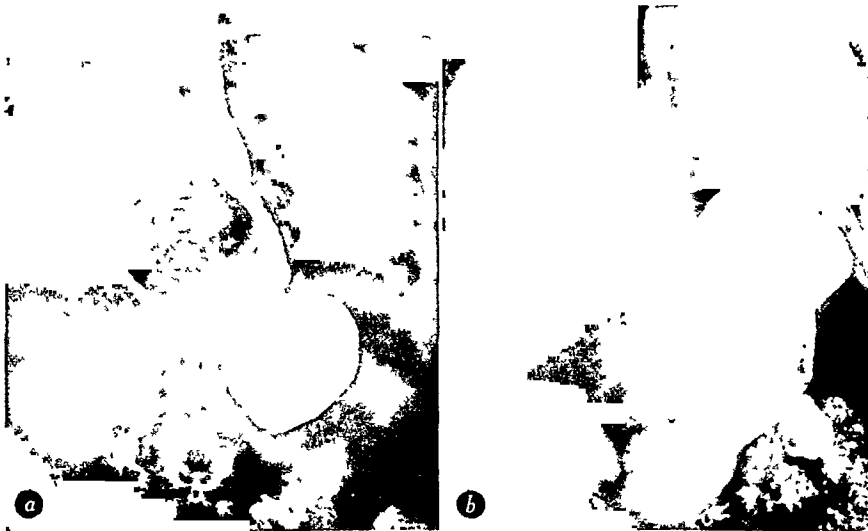


FIG. 12. *a*, patient aged 67 years. Herniation of the pyloric half of the stomach into the posterior mediastinum. Esophagus in normal position with cardiac end of the stomach in the abdomen (para-esophageal). *b*, same case after repair of the hernia. Entire stomach in normal position below the diaphragm.

sides. Hernias of this type constitute about two-thirds of the esophageal hiatus hernias on which I have operated. (Figs. 13 and 14.)

I believe that the essential difference between these two types is one of degree rather than any fundamental difference in origin. Inasmuch as these hernias are progressive in character and are in reality a sliding type of hernia, hernias of the first type may ultimately develop into those of the second type as more of the stomach becomes included in the hernial sac. In many cases of esophageal hiatus hernias there is dilatation of the lower end of the esophagus. This is usually more marked in the larger types of hiatus hernias.

With the more frequent roentgenologic recognition of small hiatus hernias in the last few years, two additional types (Fig. 10 *c* and *d*) have been recognized which may be considered pulsion types of esophageal hiatus hernias. In these types a small portion of the cardiac end of the stomach projects through the esophageal hiatus. They are probably attributable to atrophy of the elastic fibers of the diaphragmatico-esophageal membrane together with relaxation of the circular muscle surrounding the esophageal opening,



FIG. 13. *a*, patient aged 42 years. Herniation of two-thirds of cardiac end of stomach into posterior mediastinum and extension into left side of thoracic cavity. Marked elevation and displacement of esophagus. *b*, same case after operation. Entire stomach in normal position below elevated left portion of diaphragm. Esophagus normal in length and position.



FIG. 14. *a*, patient aged 39 years. Herniation of two-thirds of cardiac end of stomach into posterior mediastinum and extension into right side of thoracic cavity. Marked elevation and displacement of esophagus to right. *b*, same case after operation. Entire stomach in normal position below elevated left portion of diaphragm. Esophagus normal in length and position.

resulting in an incompetent hiatus. (Figs. 15 and 16.) Recognition and differentiation of these two types is often difficult by roentgenologic examination alone. The establishment of the diagnosis is aided by

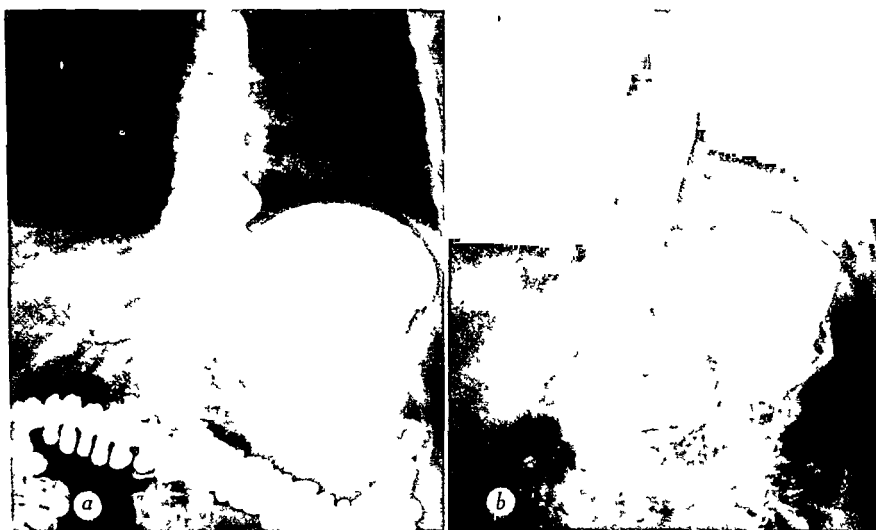


FIG. 15. *a*, patient aged 36 years. Small protrusion of cardiac end of the stomach through esophageal hiatus with distortion of lower part of esophagus. Incompetent hiatus. *b*, same case after operation. Stomach in normal position below the diaphragm and normal contour to esophagus.

an esophagoscopic examination which is often essential in arriving at an accurate diagnosis. These hernias are more commonly seen in elderly people. In many instances the finding of these hernias is incidental as the patients do not present any subjective symptoms; however, in some instances the symptoms may be severe and may not respond to conservative measures. In the latter cases, surgical intervention is necessary to relieve the symptoms.

Hernias of type 3 (Figs. 10c and 15) closely simulate the paraesophageal type of hernia except that they are relatively small. There is the beginning formation of a definite hernial sac. The esophagus is only slightly elevated, the abdominal portion being elevated to the superior border of the diaphragm. The hernia may remain small or it may develop into a true paraesophageal hernia.

In the fourth type (Figs. 10d and 16) there is incompetency of the entire hiatus with a funnel-like protrusion of the cardiac end of the stomach above the diaphragm and a comparable elevation of the esophagus which enters the apex of the protruded portion of the stomach. This type does not have a true hernial sac and may not be

considered a true hernia. This type of hernia must be distinguished in diagnosis from a congenital short esophagus with partial thoracic stomach and dilatation of the lower end of the esophagus. This is



FIG. 16. *a*, patient aged 59 years. Protrusion of the cardiac end of the stomach and elevation of the lower end of the esophagus above the diaphragm. Pulsion type of hernia (incompetent hiatus). *b*, same case after repair. Stomach in normal position below diaphragm. Esophagus normal in length and position.

best accomplished by an esophagoscopic examination to determine the length of the esophagus.

In congenital short esophagus (Fig. 10*e*) because of congenital malformation, the esophagus is not long enough to permit the stomach to reach its normal position below the diaphragm. The stomach is held suspended in the posterior mediastinum above the diaphragm. In this type of case the abnormality is often considered to be an esophageal hiatus hernia, but it is not a true hernia as the stomach has never been below the diaphragm. I believe the condition could be better described as a congenitally short esophagus with partial thoracic stomach. In my experience this condition is relatively rarely found at operation. I have operated on eleven patients who presented all of the roentgenologic signs of short esophagus but at the time of the operation I found that in four cases the esophagus, although its lower end was above the diaphragm, was of sufficient length to reach below the diaphragm when the herniated portion of the stomach was reduced. Of the remaining seven cases, in three there was a slight shortening of the esophagus

associated with a herniation of the cardiac end of the stomach, and the remaining four were cases of true short esophagus with partial thoracic stomach. In all but one it was possible to bring the

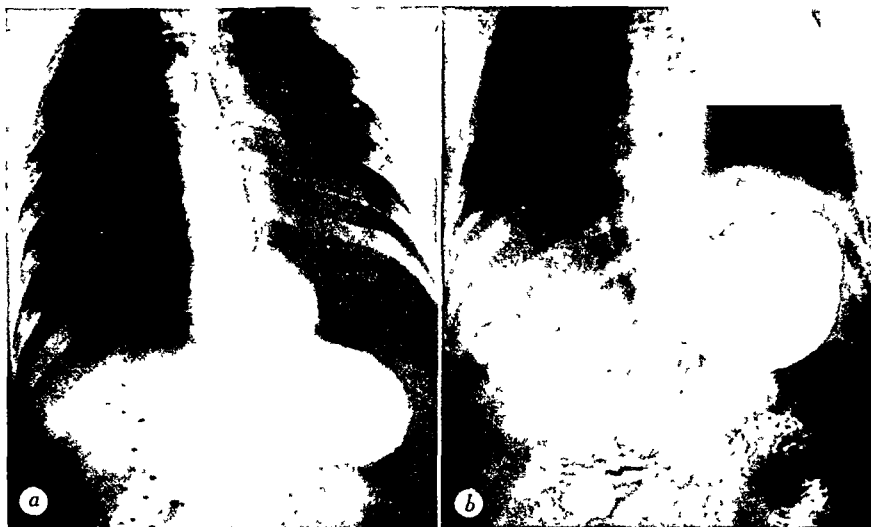


FIG. 17. *a*, patient aged 49 years. Congenital short esophagus with partial thoracic stomach; a sixth of cardiac end of stomach suspended above the diaphragm. *b*, same case one month after repair of hernia. Entire stomach in normal position below elevated diaphragm.

stomach entirely below the diaphragm after separation of the attachments around the hiatus and the elevation of the diaphragm resulting from interruption of the phrenic nerve. In one case it was impossible to bring the stomach entirely below the elevated diaphragm and it was necessary to suture a small portion of the cardia into the hiatus when the hiatus was closed. This indicates that it is not always possible by roentgenologic methods to determine the type of hernia present. I believe that this condition, although rare, is an entity but should not be grouped with the true hiatus hernias. (Fig. 17.)

This condition of short esophagus, from an etiologic standpoint, falls into two classes: first, that in which the esophagus is congenitally short, which has been described, and second, that in which ulceration and occasionally malignant neoplasm of the esophagus has caused cicatricial contraction of the lower end of the esophagus. The cicatricial contraction draws the cardia of the stomach above the diaphragm, and the condition usually is associated with stenosis of the lower part of the esophagus.

In considering cases of short esophagus from a surgical standpoint, it is important not to confuse them with true hiatus hernias, for their surgical management is entirely different. In cases of true



FIG. 18. Patient aged 28 years. Dilatation of the lower end of the esophagus with relaxation of the cardia of the stomach. Not a hiatus hernia. *a*, *b* and *c*, three views taken at the same examination. Operation not performed.

hernia, the surgical problem is that of replacement of the herniated viscera, removal of the hernial sac, and repair of the abnormally enlarged esophageal hiatus. In cases of congenital short esophagus the surgical problem is that of reconstruction and elevation of the diaphragm to a position above the stomach; this can be accomplished if the congenital shortening of the esophagus is not too great. In those cases in which the stomach is elevated above the diaphragm because of traction of cicatrices following ulceration, the symptoms usually are relieved by dilatation of the stenosed esophagus. In those cases due to malignant neoplasms, radical removal of the lesion of the esophagus is to be considered.

*Dilatation of the Lower End of the Esophagus with Relaxation of the Cardia of the Stomach.* (Fig. 10*f*.) This condition not uncommonly simulates esophageal hiatus hernias of the pulsion types both roentgenologically and clinically. In order to establish a definite diagnosis it is usually necessary to examine the esophagus with an esophagoscope as well as to carry out roentgenologic examination. At the time of the esophagosopic examination, a specimen of tissue can be removed from the wall to determine whether it is squamous cell epithelium of the esophagus or gastric mucosa of the stomach. (Fig. 18.) It is important to differentiate dilatations of the lower part of the esophagus from hiatus hernias as surgical intervention is not indicated in cases of dilatation of the esophagus.

Many writers believe that hiatus hernias are of congenital origin, although some attribute them to certain types of trauma and to senile changes in the tissue of the hiatus. However, because of the relatively few elderly persons who present hiatus hernias roentgenologically, compared to the number of patients whose stomachs are examined roentgenologically, and because of the number of elderly patients whose esophageal hiatuses I have examined in the course of various operations and have not found a hernia present, I believe that the fundamental cause of the hernia, whether the patient is elderly or young, is to be found in the embryologic formation of the diaphragm. The congenitally defective hiatus is not able to withstand the abnormal and, in some instances, the normal pulsion and traction effects of intra-abdominal and intrathoracic pressure. The stress on the hiatus does not have to be great in order to produce hernia. Fewer than 10 per cent of the patients who were proved to have hiatus hernias at operation gave histories of injury. In 50 per cent of these cases some symptoms antedated the injury; this suggests that some degree of herniation had been present prior to the injury.

#### INCIDENCE OF DIAPHRAGMATIC HERNIA

The incidence of diaphragmatic hernia is probably no greater now than it was twenty years ago. At that time the condition was thought to be uncommon and its recognition during the life of the patient was rare. A review of the records of the Mayo Clinic revealed that, from January 1, 1908, to and including December 31, 1939, the diagnosis of diaphragmatic hernia had been made either roentgenologically or at operation in 680 cases. The oldest patient was 82 years of age and the youngest patient was 3 months of age. In the first instance of diaphragmatic hernia that was observed at the clinic the hernia was of the esophageal hiatus type and was discovered at operation in 1908. The first roentgenologic diagnosis of a diaphragmatic hernia at the clinic was made in 1911. This hernia was of the traumatic type. The first roentgenologic diagnosis of an esophageal hiatus hernia at the clinic was made in 1921.

The more frequent recognition of diaphragmatic hernia in recent years is exemplified by the fact that a review of the cases in which the condition had been observed at the clinic between January 1, 1908, and December 31, 1925, inclusive, revealed that a diagnosis of this type of hernia had been made in only thirty cases. In fourteen



of the thirty cases the patients were treated surgically. From January 1, 1926 to and including December 31, 1939 on the other hand, about 650 patients had the diagnosis of diaphragmatic hernia. The author operated on 250 of these 650 patients. This study,

TABLE I  
DATA CONCERNING SITUATION, ETIOLOGY AND CONTENTS OF HERNIA

Site of Opening	Cases No.	Etiology	Cases No.	Contents of Hernia	Cases No.
Esophageal hiatus....	187	Congenital (history of trauma, 17).....	187	Stomach (omentum).	176
				Stomach, omentum and spleen.....	4
				Stomach and colon..	7
Short esophagus type.	11	Congenital.....	11	Stomach only.....	11
Hiatus pleuroperitonealis.....	4	Congenital.....	4	Colon and small bowel	3
				Colon, small bowel, stomach and spleen	1
Absent posterior fourth of left side of diaphragm.....	4	Congenital.....	4	Stomach, colon, small bowel and spleen..	3
Foramen Morgagni (substernal).....	4	Congenital.....	4	Colon and small bowel	1
				Colon and appendix..	1
Left side of diaphragm	39	Trauma: (indirect injury, 28) (direct injury, 7) (inflammatory necrosis, 4)...	39	Colon and omentum.	3
				Stomach only.....	5
				Stomach and colon...	10
				Stomach, colon and small bowel.....	7
				Stomach, colon and spleen.....	2
				Stomach, colon, spleen and small bowel...	9
				Stomach, colon, small bowel and liver....	4
				Stomach, colon, small bowel, spleen and liver.....	2
Right side of diaphragm.....	1	Trauma (indirect injury, 1).....	1	Stomach, duodenum, colon, small bowel, liver (gallbladder) and head of pancreas.....	1
Totals.....	250		250		250

therefore, disclosed that about twenty times as many diaphragmatic hernias have been recognized in the last fourteen years as had been recognized in the previous eighteen years. I believe that the condition is even more common than the present records indicate. I have examined the diaphragm in the course of other abdominal operations

and occasionally have found a small hernia that had not been recognized either clinically or roentgenologically before operation.

The relative incidence of esophageal hiatus hernia in relation to other types of diaphragmatic hernia, in my experience, is shown by a review of 250 cases of diaphragmatic hernia, in which I operated on the patients from 1926 to 1940. In this series there were 198 cases of esophageal hiatus hernia, four cases of congenital pleuroperitoneal hiatus hernia, four cases in which the hernia was the result of congenital absence of a portion of the left side of the diaphragm, four cases in which herniation occurred through the foramen of Morgagni, and forty cases in which traumatic herniation occurred through the dome of the diaphragm. This shows that herniation through the esophageal hiatus, treated surgically, was between three and four times as common as all other types of herniation combined. (Table I.)

#### SYMPTOMS

The clinical recognition of diaphragmatic hernia on the basis of the subjective symptoms alone is often very difficult. The symptoms are complex because of the various structures involved in the hernia and depend on the amount of mechanical interference with the function of the herniated abdominal viscera, on the degree of impairment of the normal function of the diaphragm and on the amount of increased pressure within the thorax which causes impairment of respiration and circulation.

The clinical syndrome of diaphragmatic hernia may be divided into two main groups: The first group occurs in cases in which the stomach is the only abdominal organ involved in the hernia. These hernias are usually of the esophageal hiatus type. The symptoms are those of intermittent and usually progressive incarceration and obstruction of the stomach. However, this type of hernia may contain various portions of the omentum depending on the amount of stomach involved in the hernia. Inasmuch as these hernias are progressive in character the entire stomach may become involved in the hernia (Fig. 19), and in these hernias the colon may also become incorporated in the hernial sac because of its attachment to the greater curvature of the stomach (Fig. 20); more rarely the spleen may become involved because of its attachment to the cardia of the stomach. These cases involving the colon may present additional symptoms of partial or complete intestinal obstruction.

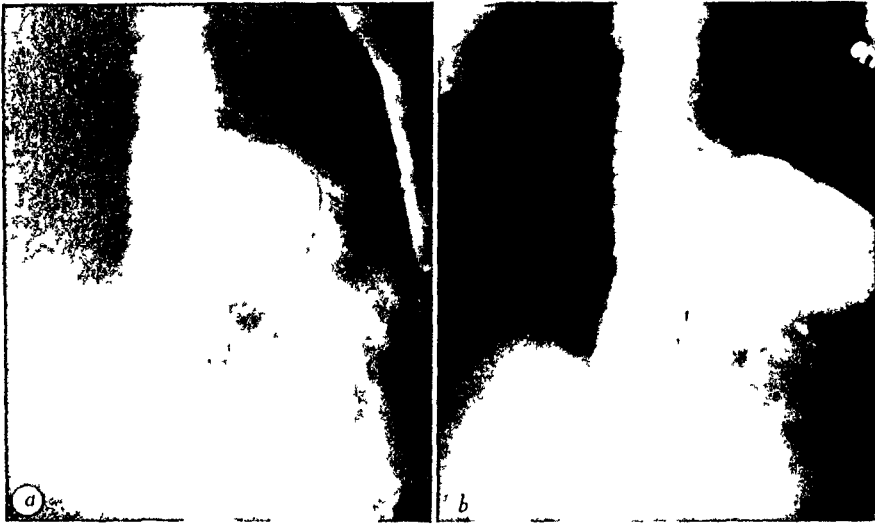


FIG. 19. *a*, first admission in 1930. Herniation of a fourth of the cardiac end of the stomach through the esophageal hiatus into the posterior mediastinum behind the heart. *b*, same case showing progressive development of hernia on second admission in 1935. Herniation of entire stomach through esophageal hiatus into the posterior mediastinum and left side of the thoracic cavity compressing and displacing the esophagus.

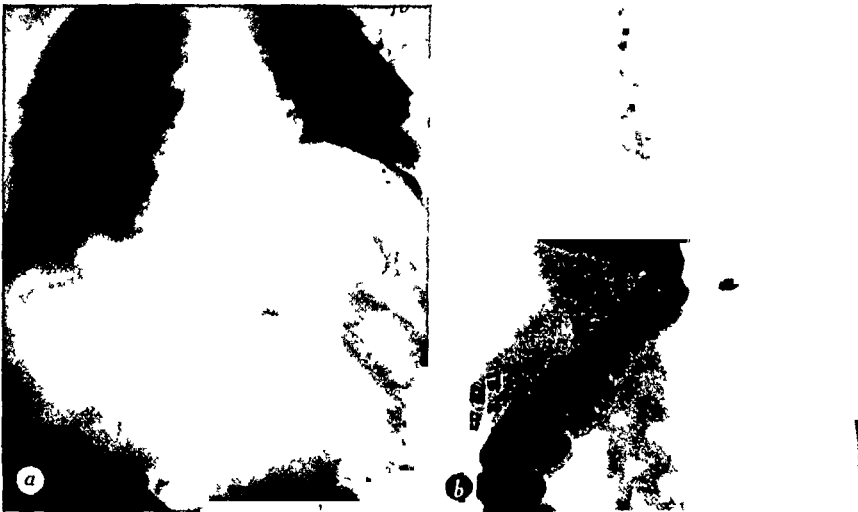


FIG. 20. *a*, herniation of the entire stomach through the esophageal hiatus into the posterior mediastinum. The stomach extends into the left side of the thoracic cavity. *b*, same case. Herniation of the transverse colon through the esophageal hiatus and projecting into the right side of the thoracic cavity.

The second group consists of those cases in which multiple abdominal viscera are involved in the hernia. These hernias are usually of traumatic origin and are caused by laceration of a normal

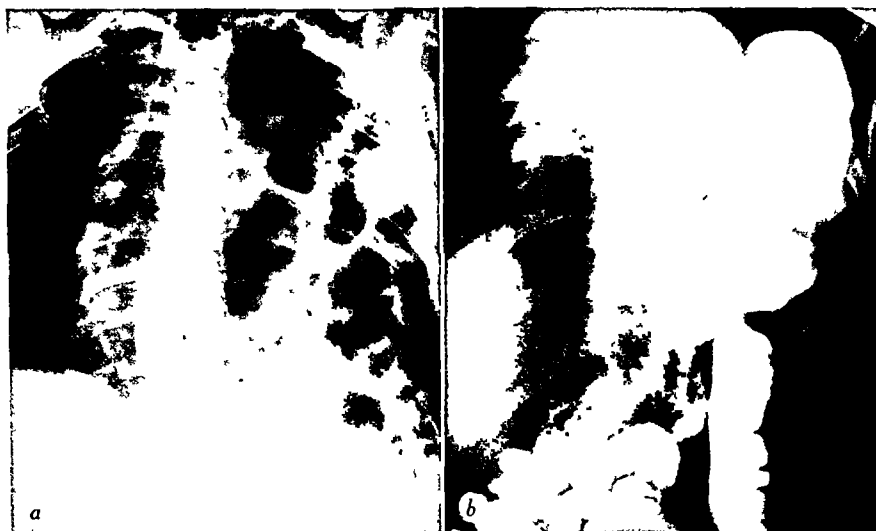


FIG. 21. *a*, entire thoracic cavity completely filled with hollow viscera displacing the mediastinum to the right. Complete collapse of the left lung. *b*, same case. Herniation of the entire stomach and transverse colon into the left side of the thoracic cavity and extending to the apex.

diaphragm. (Fig. 21.) They also may be of congenital origin and may result from congenital structural deficiency of the diaphragm. The symptoms in these cases are more varied and severe in character because of the multiple structures involved and are often more acute in onset. The initial symptom may be that of acute intestinal or gastric obstruction or severe hemorrhage.

*Esophageal Hernia.* Among adults, esophageal hiatus hernia is the most common kind of hernia through the diaphragm. This type of hernia is slowly progressive and constitutes a sliding herniation of the stomach into the posterior mediastinum. It may push into either or both sides of the thoracic cavity but does not enter the pleural cavity because the herniated viscera are confined in the hernial sac, the innermost layer of which is diaphragmatic peritoneum.

The symptoms of esophageal hiatus hernia may begin at birth or at any time during later life. Owing to the progressive character of these hernias the symptoms vary as the hernia becomes larger depending on the degree and type of herniation so that several clinical diagnoses can be made in the same case because of the

changing symptoms. Accordingly, the condition may be termed the "masquerader of the upper abdomen." In a study of 198 cases of this type of hernia in which I have performed operations, it was found that an average of three previous erroneous clinical diagnoses had been made in each of these cases before the correct diagnosis was established. The most common erroneous diagnoses, in order of frequency, were cholecystitis, cholelithiasis, gastric ulcer, duodenal ulcer, hyperacidity, secondary anemia, cardiac disease, carcinoma of the cardia, stricture of the esophagus, appendicitis and intestinal obstruction. In twenty-three of these cases the patients had been operated on previously for other conditions, without complete relief of symptoms and were completely relieved following repair of the hernia. Of these twenty-three patients, thirteen had undergone cholecystectomy previously; four, cholecystostomy; three, appendectomy; two, pyloroplasty and one, gastroenterostomy. (Fig. 22.)

The chief symptoms of esophageal hiatus hernia are pain, distress, gaseous eructation, vomiting, dyspnea, hemorrhage, weakness, anemia and palpitation of the heart. The symptoms of these hernias are more uniform than those of other types of diaphragmatic hernia and often produce a comparatively definite clinical syndrome over a period of many years. No single case will include the entire clinical picture but a study of the symptoms in a large series of these cases has suggested the composite clinical syndrome now to be described.

At the onset the attacks are usually mild; they consist of epigastric distress that is projected through to the back and which comes on in the course of, or shortly after, a heavy meal; but such attacks may be brought on by taking anything into an empty stomach, such as a cupful of coffee. The attacks are usually similar to one another in character but vary a great deal in intensity, depending on the amount of stomach that becomes incorporated in the hernia, the degree of interference with the diaphragm as well as the size of the hernial orifice and the occurrence of associated complications such as traumatic ulcer and incarceration of the stomach. The symptoms are usually relieved by belching of gas and vomiting and are commonly considered to be attributable to cholecystitis (Fig. 22a), for which the patient is often treated.

As more of the stomach becomes incorporated in the hernia, the attacks become more severe; the pain is projected straight through to the back and to the lower left side of the thorax, is more marked to the left of the spinal column than elsewhere in the back and often

appears between the scapulae. This pain may be agonizing and difficulty is experienced in belching of gas and vomiting because of spasm of the diaphragm and reflex cardiospasm. The spasm of the



FIG. 22. *a*, herniation of the cardiac fourth of the stomach into the posterior mediastinum extending into the right side of the thoracic cavity. Previously diagnosed and operated on for gallbladder disease. *b*, another case. Herniation of the entire stomach, which is inverted on itself, into the posterior mediastinum. The stomach extends into both sides of the thoracic cavity causing marked pressure on the pericardium. This case previously had been diagnosed as angina pectoris.

diaphragm produces an hourglass deformity of the stomach which interferes with emptying of the upper loculus and causes increased intragastric pressure. The pressure of the herniated portion of the stomach on the lower part of the esophagus also interferes with the belching of gas or vomiting. Spasm of the diaphragm is commonly associated with referred phrenic pain in the left shoulder, which at times may be projected down the arm. The increased pressure within the thorax causes cardiac embarrassment, with palpitation and tachycardia. The pressure on the lung and the interference with the motion of the diaphragm cause dyspnea. These symptoms are augmented when the patient lies down and in the more severe instances of the condition it is necessary for patients to sit up to breathe. The attacks may last for a few minutes to several hours and occasionally they are considered to be caused by coronary sclerosis or by myocardial disease. (Fig. 22*b*.) The attacks usually are com-

pletely relieved by vomiting and often recur immediately after food is taken.

There is often an interval of weeks or months between attacks.

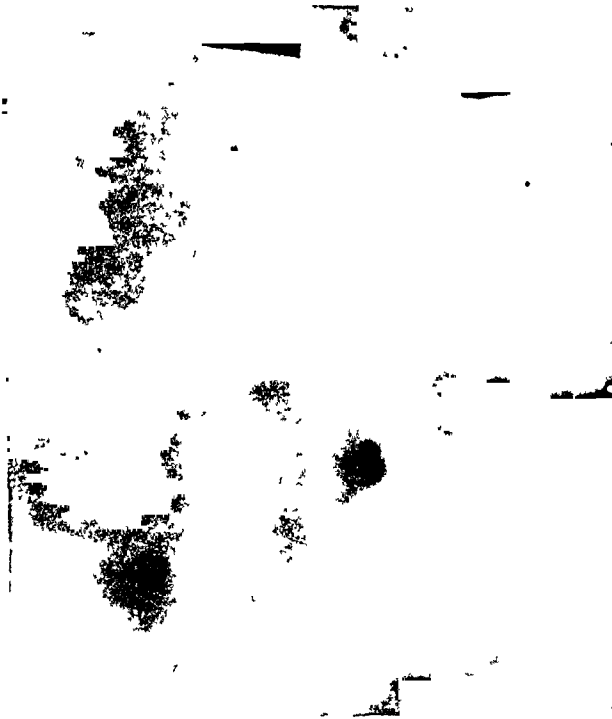


FIG. 23. Herniation of the cardiac three-fourths of the stomach into the posterior mediastinum with marked constriction at the hernial orifice, previously diagnosed and treated as peptic ulcer.

It is probable that during the interval between attacks the stomach is not incorporated in the hernial ring and is situated in its normal position below the diaphragm. When the attacks become more or less constant, the constancy usually indicates that the stomach has become fixed in the thorax by adhesions. All the early symptoms or pressure are augmented during the attacks. There is loss of weight arising from the patient's inability to retain food and from marked restriction in diet resulting from the patient's fear of bringing on an acute attack, which may be termed "food-fear." The vomiting is more severe and often is of the retention type. During the severe vomiting, the vomitus may contain blood. If the attacks are of long standing, the patient not uncommonly has a burning sensation in the

epigastrium after meals, which is relieved by taking small quantities of food. If a large amount of food is taken, it may bring on one of the attacks that is associated with incarceration of the stomach. Many of these patients present a comparatively typical syndrome of peptic ulcer, are given medical care and obtain partial relief because they have taken a restricted amount of food at frequent intervals. (Fig. 23.)

Hemorrhage is not an uncommon sign. It is due to a traumatic ulcer which is usually situated in the lower end of the esophagus close to its juncture with the stomach and it may be found in that portion of the stomach in the hernial sac near the lesser curvature. These traumatic ulcers result from the to-and-fro action of the stomach in the hernial ring when the hernia is small as well as from the forceful pressure exerted on the large distorted and congested stomach during the attacks of vomiting when the hernia is large. There is also the additional factor of regurgitation of gastric juices into the lower part of the esophagus which produces esophagitis.

The bleeding from these traumatic erosions may be severe and hematemesis or melena is often one of the chief signs. This type of hemorrhage is more commonly noted in those cases in which there occur repeated severe attacks of obstruction resulting from incarceration of the stomach in the hernial sac. In some instances the hemorrhage that results from the ulceration in these cases is so severe as to endanger life. These traumatic ulcers may be multiple and are usually relatively superficial and depend on the mechanical derangement of the herniated stomach for their presence. (Fig. 24.) After repair of the hernia and replacement of the stomach into its normal position most of these traumatic ulcerations heal spontaneously. In several instances the traumatic ulcer has become more deeply seated simulating the usual type of peptic ulcer and has not healed after repair of the hernia. In the few cases of this type that I have seen the symptoms have been of long standing or the patient's condition has been one of severe incarceration.

In other instances the patient may not be aware of any bleeding and may have a very marked secondary anemia resulting from occult hemorrhage into the stool. I should like to emphasize the importance of secondary anemia as one of the important clinical manifestations of this type of hernia. It was noted in 11 per cent of the 198 cases in which I have performed operation. However, in all cases in which traumatic ulceration was present secondary anemia



was not present, as in 19 per cent of these cases ulceration was noted on esophagoscopic examination.

The foregoing is the clinical picture of a typical case of slowly

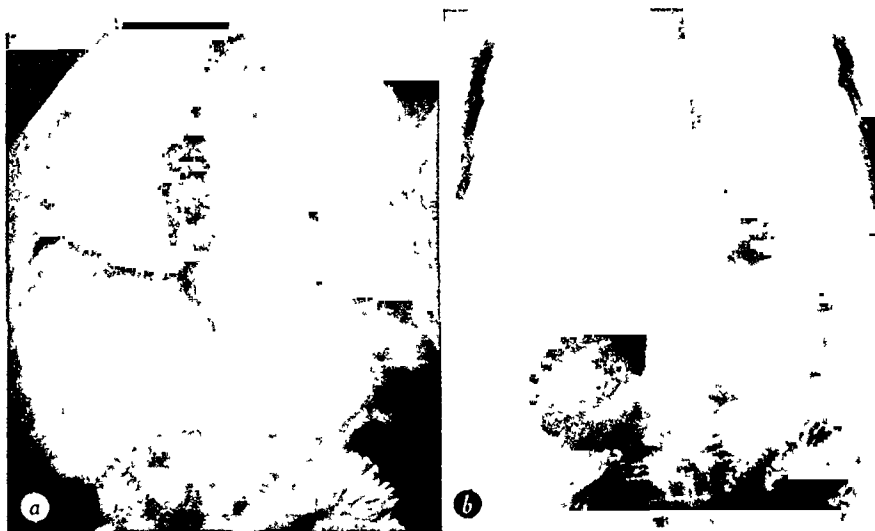


FIG. 24. *a*, herniation of the cardiac end of the stomach through the esophageal hiatus showing defect of the traumatic ulcer at the cardia above the diaphragm. *b*, same case six months after operation showing entire stomach in normal position below the diaphragm. No evidence of traumatic ulcer.

progressive herniation of the stomach through the esophageal hiatus but of course it cannot be expected that in every case all the symptoms will be present, any more than it can be expected that a typical history will be elicited in every case of any other organic condition. The chief symptoms depend on the time in the course of the disease at which the patient is examined, on the rapidity with which the hernia has been produced, on the amount of fixation of the stomach in the thorax and on the amount of disturbed function of thoracic organs.

Patients who have esophageal hiatus hernia, of which the predominating symptoms are those of esophageal obstruction, are of particular interest and require careful clinical study. The symptoms may be attributable to an entirely unassociated lesion of the lower part of the esophagus, such as cardiospasm, carcinoma, or diverticulum, or they may be the result of ulceration or stricture of the esophagus caused by the hernia. This esophageal ulceration produced by hernia is attributable to the repeated or constant pressure of the hernial sac on the lower part of the esophagus or is caused by

regurgitation of food or gastric secretion into the lower part of the esophagus. The ulceration may be a small, localized lesion or it may involve the entire circumference of the lower part of the esophagus and later may contract and produce a stricture. Because of the possibility of a lesion in the lower end of the esophagus, caused by or unassociated with the hernia, I believe esophagoscopy examination is advisable in all cases. Esophagoscopy examination is also essential in determining definitely the presence of a traumatic ulcer as these lesions are rarely demonstrable by roentgenologic examination.

It is to be remembered that patients presenting symptoms of diaphragmatic hernia may also have symptoms due to other unrelated disease, which confuse the clinical manifestations by presenting a dual complaint. I have operated on several patients who have had an associated duodenal ulcer with obstruction, gastric ulcer with obstruction and carcinoma of the pyloric end of the stomach with obstruction as well as several patients who had cholelithiasis. In cases presenting cholecystic disease as well as an esophageal hiatus hernia, I think it is advisable to operate for the cholecystic disease before the hernia is repaired (unless the hernia is incarcerated or obstruction is present) because of the clinical danger of an acute condition arising from the cholecystic disease that might produce a recurrence of the hernia from severe attacks of vomiting. If a gastric ulcer or a gastric carcinoma which obstructs the pyloric end of the stomach is associated with esophageal hiatus hernia, operation should be performed for both of these conditions at the same time.

*Congenital Hernia.* The symptoms of congenital types of diaphragmatic hernia due to structural deficiency in the formation of the diaphragm usually involve multiple abdominal viscera and are often similar to those noted in association with the traumatic types of hernia as there is rarely a confining sac and the herniated abdominal viscera are in direct contact with the thoracic viscera. The symptoms in these cases are often more severe than those noted in cases of traumatic hernia. Because of the occurrence of the hernia at birth, the respiratory and cardiac symptoms are usually the most severe owing to the marked unilateral alteration in intrathoracic pressure and the occurrence of this derangement of intrathoracic pressure at a time in which the compensatory respiratory and cardiac reserve has not been developed to a sufficient degree to maintain function of these organs. Many infants born with these congenital

defects die in the first few hours or days of life. However, if the respiratory and cardiac mechanisms are able to compensate for the presence of these abdominal viscera in the thorax, these patients may live on to childhood or even adult life without any great amount of disability or symptoms provided that intestinal or gastric obstruction does not develop. There is less likelihood of obstruction developing in these cases than in the cases of traumatic hernia because there are usually less adhesions between the abdominal viscera and the thoracic viscera in the former. When the stomach is involved in these hernias, it usually becomes markedly dilated and these patients often have symptoms of partial gastric obstruction. Intestinal obstruction may occur owing to bands of adhesions between the omentum and loops of bowel or owing to inflammatory conditions of the bowel or appendicitis.

*Traumatic Hernia.* In cases of traumatic hernia the symptoms progress very rapidly, are severe in character, and are attributable to the mechanical interference with the function of the herniated viscera as well as to marked interference with function of the heart and lungs. This is due to the fact that there is no hernial sac and the abdominal viscera are in direct contact with the thoracic viscera. The condition in these cases may be more properly termed "evisceration of the abdominal organs into the pleural cavity" rather than a "true hernia." The most marked immediate symptoms are usually those of respiratory and circulatory embarrassment. These hernias are more frequent in adult life and the compensatory cardiac and respiratory reserve usually carries the patient over the acute symptoms if the other associated injuries have not been too great. Later, severe hemorrhage from the gastrointestinal tract may occur as a result of incarceration or strangulation of the hollow viscera. If the patient survives the acute condition, the later symptoms depend on the viscera involved. The symptoms may consist of obstinate constipation, the occurrence of large quantities of gas in the colon, and attacks of partial or complete intestinal or gastric obstruction. The sudden onset of symptoms in cases of traumatic hernia usually is related directly to the injury and there is rarely a question as to the clinical diagnosis. Surgical treatment is demanded because of the danger of cardiac and respiratory failure or because of intestinal strangulation.

More frequent recognition of the condition in the last two decades has been attributable primarily to development of roent-

genologic methods of diagnosis. Clinical study of proved instances of the condition has established a fairly definite symptomatology which has enabled the clinician to diagnose the condition or to suspect the presence of a hernia and to have a special roentgenologic examination made. It will scarcely be claimed that the entire credit for the present more frequent recognition of this condition is due the roentgenologist, but he is entitled to share this credit with the clinician.

#### ROENTGENOLOGIC MANIFESTATIONS

Roentgenography plays an important role in the recognition and diagnosis of diaphragmatic hernia. It is also of great value in determining the size and situation of the defect in the diaphragm, considerations which are of aid in determining the method of surgical treatment is to be instituted.

Larger types of diaphragmatic hernias, and especially those in which a large segment of the stomach or bowel is fixed or incarcerated into the thoracic cavity, are strikingly manifest at roentgenologic examination, and often the diagnosis is self evident. But frequently despite pronounced alteration of the thoracic picture, the diagnosis cannot be established without critical study, and small or reducible hernias are likely to escape discovery unless the examiner is alert for clues that will stimulate thorough search.

Among signs suggestive of hernia that may be elicited during the routine examination of the stomach, displacement of the lower segment of the esophagus is particularly significant and is of common occurrence. In many cases, as the bariumized mixture passes down the gullet, it becomes evident that the lower portion of the esophagus is displaced mesially and that it describes a hooklike curve. In other instances the terminal segment is tortuous but not dilated. In still other cases the segment is angulated. Shortening of the esophagus is noted in the rare instances of congenital shortening. Undue retardation of the barium stream at the hiatus is another potential index of hernia and occurs in many cases.

Scarcely second in importance among signs suggestive of hernia is the observation that the level of the gastric contents is above that of the esophageal aperture. Diaphragmatic hernia is the most probable cause of this condition, and this sign aids in distinguishing hernia from eventration, for in the latter condition the two levels coincide. What apparently is high hourglass contraction of the

stomach with a visible niche at the site of constriction is, in fact, often hernia of the stomach through the diaphragm, and the ulcer is merely a complication. In many cases of hernia the symptoms are chiefly or solely thoracic and roentgenologic examination of the thorax is demanded first. Here again hernias involving the stomach and colon may be obvious, but in many cases the manifestations, although pronounced, are not diagnostic. In such cases hernia always should be taken into consideration and appropriate examination should be requested.

Reducible hernias, such as the para-esophageal variety, usually can be revealed at examination with the patient in the vertical position by pressing the stomach upward or they may be suspected by the presence of one or more of the signs already described, but fluoroscopic examination in the horizontal position is always necessary to confirm the diagnosis and to determine the extent of herniation. In no instance can hernia of the colon be excluded confidently without employing the barium enema, and when only the small bowel is implicated, repeated observations after the patient has ingested an opaque meal are necessary for diagnosis. In the rare cases of hernia through the right arch of the diaphragm, a portion of the liver usually projects through the breach and is likely to be mistaken for a neoplasm. On the whole, however, few diaphragmatic hernias should elude roentgenologic disclosure and specific diagnosis.

Roentgenography not only plays a very important role in the recognition of diaphragmatic hernia but is of equal value in the differential diagnosis of this from other conditions in which the clinical symptoms often simulate those of diaphragmatic hernia. It is also of value in determining the presence of any obstructing lesion of the esophagus. However, these lesions are more accurately determined by examination of the esophagus. I believe it is essential that all patients with diaphragmatic hernia should not only complete roentgenographic examination but also thorough esophagosopic examination before surgical intervention.

Stricture of the lower part of the esophagus associated with esophageal hiatus types of diaphragmatic hernia is not uncommon; these strictures often result from cicatricial contraction of a traumatic ulcer caused by the hernia. It is important that these associated strictures are recognized before surgical treatment is considered for the hernia because in many instances dilatation of the esophagus will

relieve the symptoms sufficiently so that no surgical treatment is necessary for the hernia. In other instances the esophagus may be shortened so that the hernia could not be reduced by surgical procedures. (Fig. 25*a* and *b*.)



FIG. 25. *a*, stricture of esophagus associated with esophageal hiatus diaphragmatic hernia showing marked contraction of the lower end of the esophagus just above the herniated portion of the stomach. *b*, herniation of the cardiac half of the stomach through the esophageal hiatus with a moderate contraction of the esophagus immediately above the herniated portion of the stomach. Esophagoscopy examination showed the esophageal defect to be due to carcinoma which was proved by tissue removed for microscopic examination.

Carcinoma of the lower end of the esophagus may be associated with diaphragmatic hernia. The presence of these lesions can usually be determined by roentgenographic examination but should be confirmed by esophagoscopy examination with removal of tissue.

Other conditions which are not definitely associated with a hernia may produce clinical symptoms which suggest diaphragmatic hernia and can be distinguished only by roentgenographic or esophagoscopy examination. Some of the more common of these conditions are cardiospasm, diverticulum of the lower end of the esophagus, diverticulum of the stomach close to the cardiac orifice and eventration of the diaphragm. (Figs. 26 and 27.)

#### SURGICAL TREATMENT

Diaphragmatic hernia is primarily a mechanical condition, and the only treatment which will relieve the condition is operative

repair or reconstruction of the abnormal opening in the diaphragm. The indications for surgical intervention and the methods and technic of surgical procedures depend on the type, situation and



FIG. 26. *a*, cardiospasm with dilatation of the esophagus. *b*, diverticulum of the lower end of the esophagus.

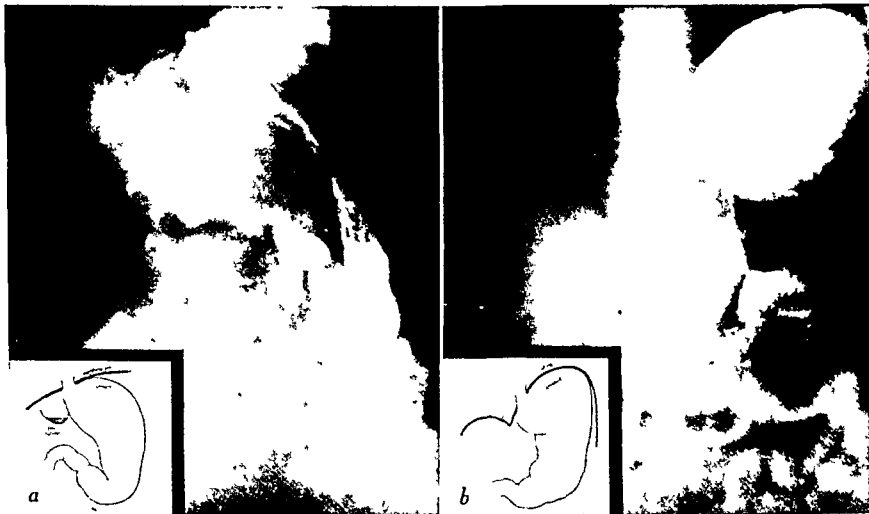


FIG. 27. *a*, diverticulum of the stomach close to the cardiac orifice. *b*, eventration (elevation) of the left side of the diaphragm.

size of the defect in the structure of the diaphragmatic muscle (Fig. 28), the kind and amount of abdominal viscera involved in the hernia, and whether or not the viscera are enclosed in the

hernial sac. I shall first describe the general surgical methods to be used and then consider the special technic which is required in the surgical treatment of some types of hernia.

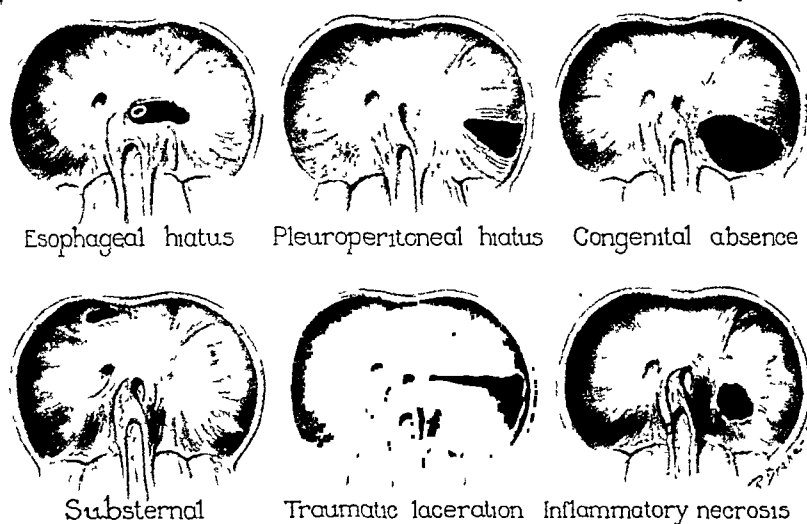


FIG. 28. Situations of congenital structural defects and traumatic lacerations of the diaphragm which cause the more common types of diaphragmatic hernia. (*West. J. Surg.*, 44: 255, 1936.)

From the standpoint of treatment cases of hiatus hernia may be divided into three groups: In the first group the hernia is small and is recognized roentgenologically, often during the course of a general examination, and causes few or no clinical symptoms. No treatment is indicated in this group of cases. The second group includes those cases in which the symptoms are moderate and the hernias are of moderate size; in many of the cases in this group, conservative treatment, such as regulation of diet and reduction of weight, is sufficient to relieve the symptoms. The third group includes those cases in which there is no response to conservative measures; in these cases the hernias usually are large, and in many cases, in my experience, there are complications, such as incarceration of the stomach or gastric erosion. In this group of cases the only treatment that assures relief of symptoms is operative repair of the hernia.

In all cases in which a third or more of the stomach is involved in the hernia, surgical intervention should be considered because the condition is progressive and usually the progressive enlargement becomes more rapid after the hernia has attained this size. Operation should be performed before severe incarceration, with consequent



obstruction and traumatic lesions of the stomach, has occurred. The operative risk is increased by gastric retention, and the technical difficulties are enhanced by fixation of the stomach to the diaphragm and to the hernial sac within the thorax. In all cases in which the colon is involved in the hernia, early operation is necessary because of the danger of occurrence of intestinal obstruction.

Other types of hernia, such as traumatic hernia or those in which there is a congenital absence of a portion of the diaphragm, should be treated surgically, because the colon and small bowel are usually involved in the hernia and there is great danger of the occurrence of intestinal obstruction. In cases of traumatic hernia it is best not to operate until the acute symptoms caused by the primary injury have subsided, if the patient's condition will permit this delay.

*Interruption of the Phrenic Nerve.* Paralysis of the diaphragm, produced by either temporary or permanent interruption of the phrenic nerve, is of value as a procedure performed preliminary to radical operative repair of many different types of diaphragmatic hernia. It is a necessary procedure in the surgical treatment of partial thoracic stomach resulting from a congenitally short esophagus. In some cases in which radical operative repair is contraindicated, it may be used as a palliative measure. In most instances in which interruption of the phrenic nerve is utilized as a procedure preliminary to radical operative repair of the hernia, I prefer, first, to perform temporary interruption of the nerve by crushing it in the cervical region because in many instances it may not be necessary for the resultant paralysis to be permanent. Function is usually reestablished within three to six months. In cases in which reestablishment of function of the diaphragm is not desirable because of the danger of recurrence of the hernia, the paralysis can be made permanent by cutting or avulsing the phrenic nerve. As a procedure preliminary to radical surgical treatment, interruption of the phrenic nerve often is of value in the treatment of incarcerated and strangulated hernias because it prevents spasm of muscle and causes relaxation of the hernial ring. It is of great advantage in the closure of large hernial openings when there is considerable loss of structure of the diaphragm, as is usually found in traumatic or congenital hernias.

In this type of hernia interruption of the phrenic nerve may be done in the cervical region preliminary to the abdominal repair of the hernia or the nerve may be crushed or cut along its course in the

mediastinum through the hernial orifice at the time of operation. The relaxation of the diaphragm following this procedure permits the structural defect to be closed without tension; and in cases of traumatic hernia in which the diaphragm has been torn from the thoracic wall, it permits the diaphragm to be sutured to the intercostal muscles.

Interruption of the phrenic nerve may be utilized as a palliative measure in esophageal hiatus diaphragmatic hernia when the radical operative procedure of closure of the enlarged esophageal hiatus is contraindicated because of the patient's condition and when the stomach is the only abdominal viscus involved in the hernia. The purpose of this procedure is to prevent spasm of the diaphragm, which is the cause of the severe instances of incarceration of the stomach in the hernial sac.

Phrenic nerve interruption without operative repair of the hernia does not completely relieve the symptoms. There is always a moderate amount of gastric distress immediately after, or shortly after, the ingestion of heavy meals, but the patients maintain themselves rather well if they are careful with their diet. This procedure is not applicable to hernias in which a large portion of the stomach lies in the thorax, causing marked pressure on the heart and lungs, nor is it applicable in any case in which the intestines are involved in the hernia. This procedure should not be employed when radical operative repair can be effected.

*Radical Surgical Repair. Anesthesia.* The method of administration of the anesthetic agent depends on the type of hernia which is present. In all cases in which there is no hernial sac, and in which there is a direct communication between the abdominal and thoracic cavities, I prefer intratracheal administration of the anesthetic agent by means of a positive pressure machine. The anesthetic agent to be used depends on the indications presented in each individual case. I have used ether, ethylene and cyclopropane. I prefer the latter. In cases in which there is a hernial sac, as in the esophageal hiatus type of hernia, the anesthetic agent can be administered by the closed mask method.

*General Technical Considerations.* In the treatment of all hernias that have occurred through the left portion of the diaphragm, I prefer the abdominal approach by means of an oblique left rectus incision, starting at the ensiform cartilage and extending to the outer border of the rectus muscle. I believe there is less risk of the

mal position by adhesions, that it cannot be separated from the hernial opening without seriously injuring it. This not uncommonly occurs in the traumatic types of hernia, and occasionally in esophageal hiatus hernias. In these cases splenectomy is necessary.



FIG. 32. Same case as that represented in Figure 29, after operation. Stomach in normal position below repaired left side of diaphragm. Right lung fully expanded.

*Esophageal Hiatus Hernia.* Hernias through the esophageal hiatus are true hernias and have a hernial sac. (Figs. 29, 30, 31 and 32.) The attachment of the sac to the stomach must be separated and the sac must be either completely removed or permitted to retract into the posterior portion of the mediastinum. I believe that this is one of the most important technical considerations in the surgical treatment of these hernias.

After the sac has been removed, the enlarged esophageal hiatus is repaired by overlapping the margins of the opening. Closure is usually made to the left of the esophagus but in some cases it is necessary to close the opening partially both to the right and left of the esophagus. (Fig. 33.) In a few instances the enlargement of the esophageal opening is posterior, extending to the spinal column

and requiring the overlapping of the margins posterior to the esophagus. In such cases, the condition is often thought to be a herniation through the aortic opening, but extending over the aorta there

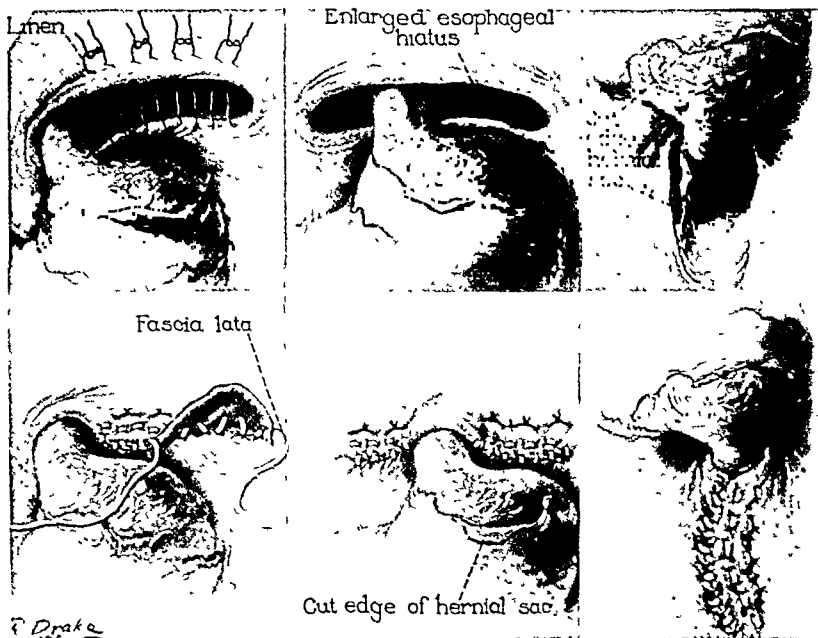


FIG. 33. The more common types of structurally deficient esophageal openings which permit herniation of the stomach into the posterior mediastinum and the method of repair of each type of opening with fascia lata and linen after removal of the hernial sac. (*West. J. Surg.*, 44: 255, 1936.)

usually is an imperfectly developed, fibrous band which is the margin of the defective esophageal hiatus. The closure is usually made with living sutures of fascia lata which are removed from the thigh. (Fig. 34.) The overlapped margins of the hernial opening are first stabilized with interrupted linen sutures. The fascia lata is then woven into the tissues by continuous suture and fixed in the tissues with interrupted linen sutures.

In many cases in which the stomach is incarcerated (Fig. 35) or obstructed, it is impossible to pass a stomach tube into the obstructed loculus of the stomach before operation. In these cases it is advisable to pass a stomach tube soon after the abdomen is opened, directing the tube into the obstructed portion of the stomach in order to empty the gastric contents before any attempt is made to reduce the herniated viscera, because of the danger of regurgitation and aspiration of gastric contents into the lung.

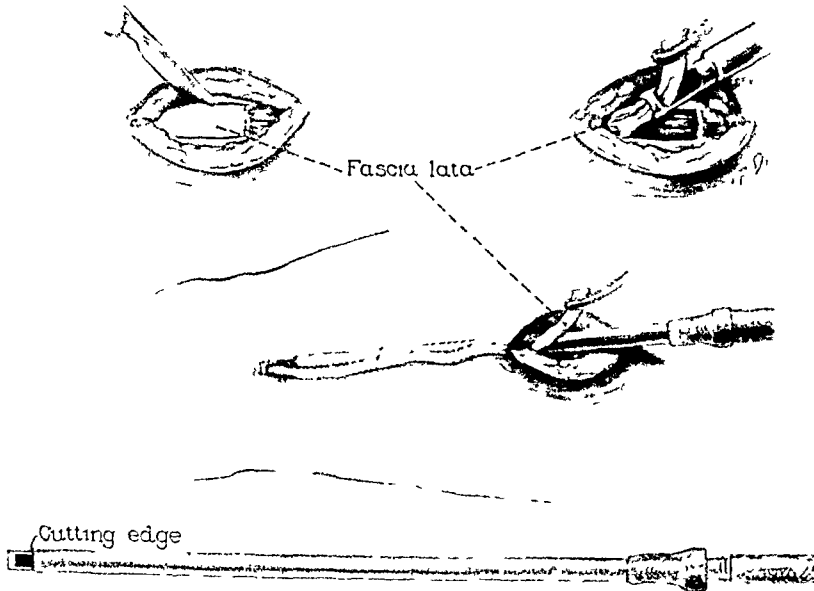


FIG. 34. Method of removal of the fascia lata from the thigh with a Masson fascial stripper. The fascia is divided into strips and utilized in repair of the hernia.



FIG. 35. *a*, patient aged 55 years. Incarcerated esophageal hiatus hernia with obstruction. Herniation of cardiac half of stomach with elevation and displacement of lower part of esophagus. *b*, same case at operation. Separation of adhesions fixing stomach to margins of hernial orifice. Inserts reveal repair of hernia with linen and fascia lata. *c*, same case after repair of hernia. Stomach in normal position below elevated left side of diaphragm. Esophagus in normal position.

Before closure of the defective esophageal hiatus is completed around the lower part of the esophagus, it is important that a stomach tube of large caliber be passed through the esophagus into



FIG. 36. *a*, patient aged 56 years. Esophageal hiatus hernia producing large gastric ulcer. Acute incarceration of cardiac end of stomach in hernial sac with large gastric ulcer high on lesser curvature. *b*, same case at operation, showing large traumatic ulcer at the junction of the esophagus and cardia of the stomach on the lesser curvature with inflammatory adhesions fixing the stomach to the inner margin of the hernial opening. Inserts reveal repair of esophageal hernia with interrupted sutures of linen and with fascia lata after replacement of the stomach into the abdomen and gastroenterostomy after closure of the traumatic ulcer. *c*, same case after operation. Entire stomach in normal position below elevated left side of diaphragm. Posterior gastroenteric stoma is functioning normally.



FIG. 37. *a*, patient aged 64 years. Esophageal hiatus diaphragmatic hernia with herniation of two-thirds of cardiac end of stomach and upper pole of spleen into posterior mediastinum. *b*, same case at operation. Abdominal exposure of herniated stomach and spleen. Inserts show repair of esophageal hiatus with linen and fascia lata. *c*, same case after repair of hernia and splenectomy. Stomach in normal position below elevated left side of diaphragm.

the stomach, to aid in the reconstruction of the normal esophageal opening and to prevent constriction of the esophagus by a tight

closure. The loose areolar tissue or a small portion of the esophageal wall at the cardia is incorporated in the innermost margin of the closure by a suture of chromic catgut.

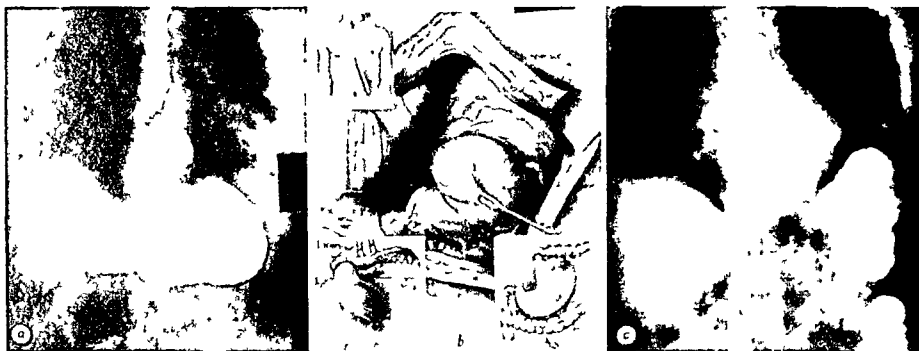


FIG. 38. *a*, patient aged 63 years. Esophageal hiatus diaphragmatic hernia with an obstructing duodenal ulcer. Herniation of cardiac third of the stomach through the esophageal hiatus into posterior mediastinum compressing and displacing lower third of esophagus. *b*, same case at operation. Removing herniated stomach from mediastinum. Large, obstructing, perforating duodenal ulcer. Closure of enlarged esophageal hiatus with fascia lata and posterior gastroenterostomy. *c*, same case after operation. Entire stomach in normal position below left side of diaphragm, elevation of which is due to interruption of phrenic nerve. Gastroenteric stoma free.

Not uncommonly in these cases there is an associated traumatic ulcer in the herniated portion of the stomach, along the lesser curvature, close to the cardia (Fig. 36), and this ulcer is often adherent to the margins of the hernial opening. Great care should be used in replacing the stomach in the abdomen, and in removing the sac from the stomach because of the danger of perforating this thinned-out portion. In cases in which the ulcerated portion is penetrated, it should be repaired immediately with continuous catgut and linen sutures. The spleen is not uncommonly involved in the hernia of the esophageal hiatus type. In a few cases, particularly those in which the opening is posterior, the spleen may not only be adherent to the margin of the opening but may be herniated into the thoracic cavity. In these cases there is usually considerable obstruction to the stomach. The separation of the adhesions in order to replace the stomach and spleen into the abdomen may so traumatize the spleen that its removal may be necessary. (Fig. 37.)

The abdomen always should be thoroughly explored for the presence of any other lesion, particularly of the stomach or gall-bladder. In some cases it may be necessary to operate on other associated lesions. However, I do not believe it advisable to carry out

any additional surgical procedure at the time of repairing the hernia, unless it is imperative, but it is well to know whether the patient has gallstones or any other lesion in the upper part of the abdomen, which might account for subsequent symptoms. (Fig. 38.)



FIG. 39. *a*, patient aged 53 years. Congenital short esophagus with partial thoracic stomach. Approximately a sixth of the stomach is suspended above the diaphragm by the short esophagus which enters the upper part of the stomach. Left side of diaphragm in normal position. *b*, same case after operation. Stomach entirely below elevated left side of diaphragm. Note position of left side of diaphragm as compared to that of right side both before and after operation.

*Congenital Short Esophagus.* The surgical treatment of congenital short esophagus with partial thoracic stomach presents an entirely different technical problem from that of esophageal hiatus diaphragmatic hernia. As pointed out previously, the essential consideration in the surgical treatment of esophageal hiatus hernia is that of replacement of the herniated stomach into the abdomen, the removal or obliteration of the hernial sac and the repair and reconstruction of the esophageal hiatus accurately around the esophagus.

Congenital short esophagus with partial thoracic stomach is not a true hernia of the diaphragm in that the stomach has never been in its normal position below the diaphragm because of shortening of the esophagus. The surgical problem in these cases is that of reconstructing the diaphragm over the elevated portion of the stomach; this can be accomplished if the shortening of the esophagus is not too great. By interruption of the phrenic nerve (complete and



permanent) the diaphragm usually can be elevated from 2 to 5 cm. and then by completely separating the attachment of the esophagus from the attachments around the esophageal hiatus, from 2 to 3 cm. of the esophagus can be drawn down into the abdomen. The elevation of the diaphragm and the pulling down of as much as is possible of the esophagus into the abdomen permit the esophageal hiatus to be closed around the lower end of the esophagus, placing what was formerly the thoracic portion of the stomach below the diaphragm. (Fig. 39.)

*Congenital Diaphragmatic Hernias Due to Malformation and Structural Deficiencies.* These hernias may occur in either the right or the left side of the diaphragm but are much more common through the left side. The more common hernias of this type are those through the pleuroperitoneal hiatus, those due to the lack of formation of the posterior portion of the diaphragm and those through the foramen of Morgagni (Larrey's space), anteriorly, more accurately termed substernal hernias.

In the first two types there is rarely if ever a hernial sac and the abdominal viscera are in direct contact with the thoracic viscera. In the latter type (substernal) there is always a hernial sac which consists of peritoneum and parietal pleura.

The anesthetic agent in the first two types of hernias should be administered under positive pressure after introduction of an intratracheal tube because of the dangers associated with open pneumothorax, as these hernias do not have a hernial sac and are essentially eviscerations of the abdominal contents into the thorax. In the latter type, substernal hernias, the anesthetic agent may be administered with a closed mask.

In the surgical treatment of these hernias the approach in the first two types may be either thoracic or abdominal but I prefer the abdominal approach through an oblique left rectus incision. In the latter type (substernal) the approach should always be through the abdomen and usually through an oblique right rectus incision or a transverse incision in the epigastrium. I prefer the oblique right rectus incision.

*Pleuroperitoneal Hiatus Hernias.* These hernias occur in the posterolateral portion of the diaphragm and are due to failure of fusion of the pleuroperitoneal membrane and the septum transversum. The defect is usually triangular in shape with the apex toward the median portion of the diaphragm. The defect usually

extends to the chest wall but occasionally there is an imperfectly developed band of muscle tissue extending along the chest wall. These hernias do not have a hernial sac and there is a direct communication between the abdominal and the thoracic cavity.

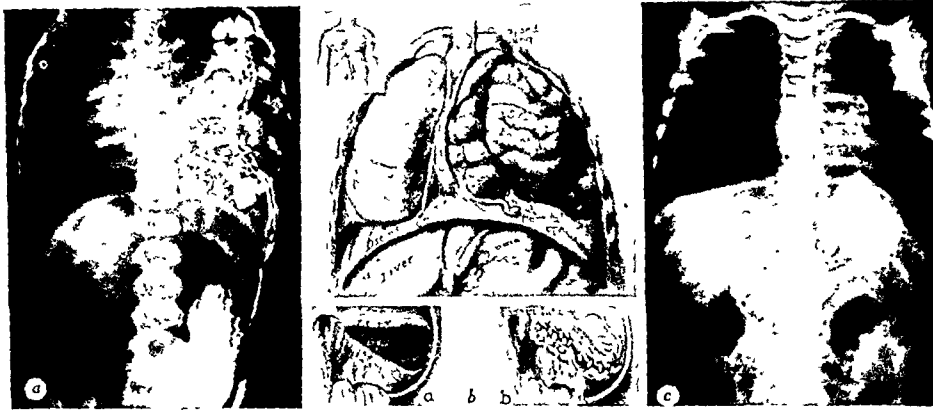


FIG. 40. *a*, patient aged 3 years. Pleuroperitoneal hiatus hernia with herniation of colon and small bowel extending to apex of left side of thoracic cavity, compressing lung and pushing mediastinum to right. Dilated stomach visualized in the lower part of the abdomen. *b*, same case at operation. Left side of thoracic cavity filled with large and small intestine collapsing left lung and pushing mediastinum to right. Insert *a*, persistent pleuroperitoneal hiatus defect. Insert *b*, closure of congenital defect in diaphragm with interrupted silk and continuous fascia lata. *c*, same case on dismissal. Mediastinum in normal position. Left lung fully expanded. Herniated viscera in normal position below diaphragm.

The most common abdominal viscera involved in this type of hernia are the colon and small bowel. There may or may not be herniation of the spleen and stomach. There is often a failure of rotation of the colon and the entire right colon (appendix and cecum) with the terminal part of the ileum and all of the small intestines to the jejunum are involved in the hernia. (Fig. 40.)

This type of hernia is said to be the most common of the congenital types of hernia due to structural deficiencies. These hernias are present at birth. Many of the infants suffering from them die in the first few hours or days of life because of respiratory and cardiac embarrassment and before surgical intervention can be instituted. In treating those infants who are able to survive in spite of the altered intrathoracic pressure and thoracic visceral relationship, surgical intervention should be instituted as soon as possible because of the danger of intestinal obstruction. If they are able to maintain nourishment, it is well to delay operation for two to three months to permit some development of their accessory respiratory mechanism.

If operation is delayed for a long period, the abdominal viscera will have lost their right of residence in the abdomen in that the abdominal cavity will not have developed sufficiently to contain them and



FIG. 41. Same case as that represented in Figure 40. *a*, roentgenogram taken immediately following operation (on operating table) showing complete collapse of left lung. Marked shift of heart and mediastinum to right. *b*, roentgenogram taken thirty minutes later than *a* after withdrawal of 700 cc. of air. Heart and mediastinum in normal position. Left lung still collapsed. *c*, roentgenogram taken three days after operation. Heart and mediastinum in midline. Partial expansion of the left lung.

there will be marked increase in the intra-abdominal pressure when the viscera are replaced into the abdomen.

In the smaller hernias of this type the opening can be closed without utilizing interruption of the phrenic nerve. In the larger hernias it is a necessary procedure. The opening is completely closed by overlapping the margins from 2 to 3 cm. In infants this closure is made with interrupted silk. Before the opening is completely closed, the air is aspirated from the pleural cavity by inserting a catheter connected to a suction apparatus. At the time of withdrawal of the catheter the last suture is tied, completely closing the communication between the thorax and the abdomen. (Fig. 41.)

One of the chief dangers associated with the repair of these hernias is marked alteration of intrathoracic or intra-abdominal pressure. It is very important in these cases that the respiratory function be maintained by positive pressure during the operation and that at the completion of the operation a negative pressure be obtained and secured in the thoracic cavity. A roentgenogram should be taken at the completion of the operation to see that there is no shift of the mediastinum due to the pneumothorax. I do not permit the patient to leave the operating table until I have seen the roent-

genogram. If there is any shift in the mediastinum, more air is withdrawn to maintain the mediastinum in the midline.

*Congenital Absence of the Posterior Half of the Diaphragm.* This

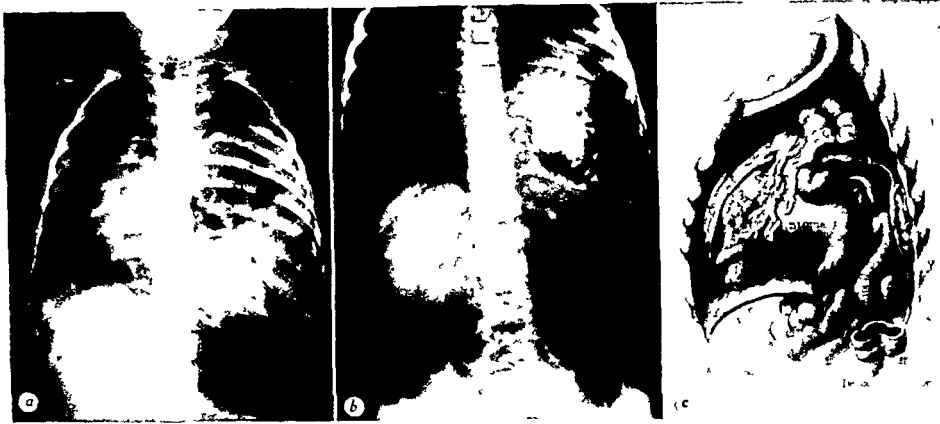


FIG. 42. *a*, patient aged 3 years. Congenital absence of portion of diaphragm. Left side of thoracic cavity almost completely filled with hollow viscera displacing the mediastinum to the right. *b*, same case. Entire stomach in left side of thoracic cavity. Colon distended with air and seen to the outer side and extending above the stomach. *c*, same case at operation. Eventration of colon, small bowel, stomach and spleen into left side of thoracic cavity, completely collapsing lung. Left kidney retropleural.

type of hernia is due to failure of the formation of that portion of the diaphragm which is derived from the pleuroperitoneal membrane. The defect is in the posterolateral portion of the diaphragm and usually extends from the eighth rib posteriorly and medially to the esophageal hiatus. These hernias usually do not have a sac but there may be an imperfectly developed enveloping membrane of peritoneum and omentum which simulates a sac. These hernias may be considered an enlargement of the foregoing pleuroperitoneal type in that the essential difference is a much more extensive congenital defect in the formation of the diaphragm. There are more abdominal viscera involved in the hernia in that these hernias always contain the stomach and spleen as well as the large and small bowel and occasionally the left kidney is elevated above its normal level into the pleural cavity. (Fig. 42.)

Not only do the surgical problems associated with these hernias involve all of the problems of the pleuroperitoneal hernias as far as altered intra-abdominal and intrathoracic pressure is concerned but in addition there is the problem of closing this large gap with the diaphragmatic muscle that is present and of reconstructing the attachment of the diaphragmatic muscle to the chest wall. (Fig. 43.)

In some instances the posterior perirenal fascia may be utilized in obtaining this closure and fixation to the chest wall. This can be accomplished if the gap is not too great by complete, permanent

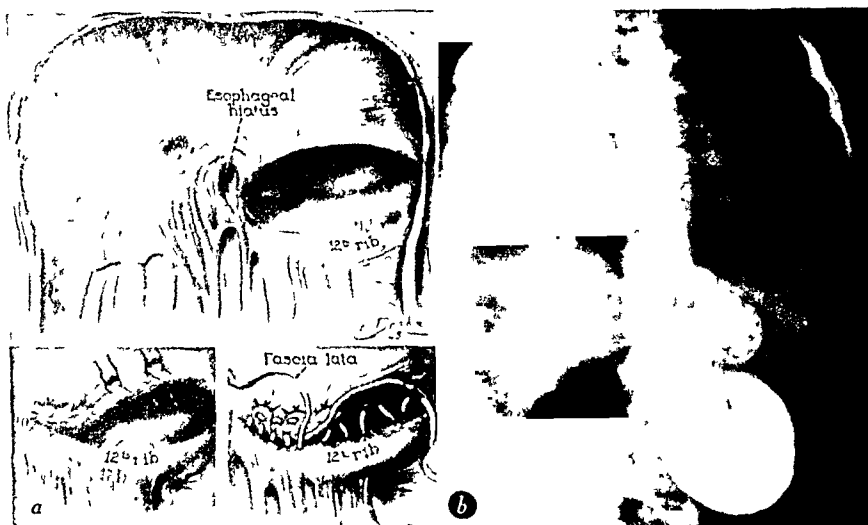


FIG. 43. *a*, same case as that represented in Figure 42, at operation. Absence of posterior part of left side of diaphragm. Repair of defect by suturing posterior margin of diaphragm to intercostal muscles with fascia lata. *b*, same case after operation. Stomach in normal position below the left side of diaphragm which is in normal relation to right side of diaphragm. Heart and mediastinum in normal position. Lung fields negative.

interruption of the phrenic nerve. If the defect is too large to permit the relaxed diaphragm to span this gap, it is necessary to shorten the diameter of the diaphragm by an extrapleural rib resection.

*Substernal Hernia through the Foramen of Morgagni (Larrey's Space).* This is one of the rarest types of diaphragmatic hernia. It is usually seen in adult life but is essentially congenital in origin. The opening in the diaphragm is usually immediately beneath the right side of the sternum and right costal margin through a slit in the anterior portion of the diaphragm (foramen of Morgagni, Larrey's space), or there is a linear separation of the diaphragm from the anterior chest wall extending entirely beneath the sternum more to the right side of the midline. These hernias always have a hernial sac of peritoneum and the round ligament of the liver is usually incorporated in the peritoneum which forms the sac.

The herniated abdominal viscera which are most commonly found in these hernias are the omentum and transverse colon. There may be nonrotation of the colon with herniation of cecum, appendix,

terminal parts of the ileum, ascending colon and part of the transverse colon. When the omentum only is contained in the hernia, the condition is not uncommonly thought to be an intrathoracic tumor.



FIG. 44. *a*, patient aged 55 years. Substernal (foramen of Morgagni—Larrey's space) diaphragmatic hernia. Rounded shadow in right lower quadrant of thorax above diaphragm obscuring right border of heart and lung field. *b*, same case at operation. Abdominal approach. Herniation of omentum and colon through opening to right of ensiform cartilage. *c*, same case after operation. Right lung entirely expanded. Diaphragm, heart and lung fields negative.

In cases in which the colon is herniated, the condition can be recognized from the roentgenogram for the colon may be seen to extend to the top of the thoracic cavity on the right side. These hernias are repaired through right rectus incisions. The herniated omentum and colon are replaced into the abdomen. If the hernial sac is small, it can be inverted and excised. In the larger hernias in which the sac extends high into the pleural cavity, it is best to leave the sac in situ because of the danger of hemorrhage which may be associated with its removal or of injury to the pleura. In these cases the round ligament is cut and later sutured to the abdominal wall. The hernial opening in the diaphragm is closed with interrupted linen sutures. The closure is reinforced with a continuous layer of fascia lata removed from the thigh. The round ligament of the liver is then sutured over this closure. In cases in which there is a very large opening, it may be necessary to suture the overlapped margins of the opening to the chest wall in order to obliterate the hernial orifice completely. (Fig. 44.)

*Traumatic Diaphragmatic Hernia.* These hernias may result from direct or indirect injury to the diaphragm. The hernia may occur in either the right or the left side of the diaphragm but it

much more commonly occurs in the left side. The laceration may occur in any portion of the diaphragm but it is most common in the posterolateral portion and dome of the diaphragmatic muscle. The



FIG 45. *a*, patient aged 42 years. Rupture of right side of diaphragm with herniation of pyloric half of stomach and duodenum into right side of thoracic cavity. *b*, same case at operation. Liver, gallbladder, stomach, duodenum, pancreas and colon in right pleural cavity causing collapse of right lung.

laceration may extend across the entire leaf of the diaphragm and occasionally extends into the opposite side of the diaphragm. These lacerations occasionally split the esophageal hiatus but in most instances the circular muscle of the hiatus remains intact. The laceration involves the entire width of the diaphragmatic muscle producing a direct communication between the abdominal and the thoracic cavity and there is no hernial sac. The condition may be more properly termed an evisceration than a true hernia.

Any of the abdominal organs but those in the pelvis may be involved in these hernias. The most common are the stomach, large and small bowel, spleen and liver. The herniated abdominal viscera may entirely fill the hemithorax and extend to the apex of the thoracic cavity causing complete collapse of the lung with marked displacement of the mediastinum.

The surgical approach to these hernias may be through the thorax or through the abdomen. For all hernias through the right side of the diaphragm, I prefer the thoracic approach because the

large right lobe of the liver interferes with the exposure of the right side of the diaphragm. In hernias of this side the right lobe of the liver is often incorporated in the hernia and its reduction is more



FIG. 46. *a*, same case as that represented in Figure 45. Thoracic approach at operation. Condition after replacement of herniated abdominal viscera. Separating margins of laceration from liver and overlapping repair of the diaphragm. *b*, same case after operation. Stomach and colon in normal position below the diaphragm. Partial expansion of right lung and thoracic deformity resulting from rib resection.

safely accomplished through the thoracic approach because there is less danger of hemorrhage from injury to the liver. (Figs. 45 and 46.)

In all traumatic hernias through the left side of the diaphragm, I prefer the abdominal approach through an oblique left rectus incision. The herniated viscera are usually very adherent to both the abdominal and the thoracic side of the diaphragm and to the structures within the thorax. The adhesions to the margins of the opening and to the under surface of the diaphragm are often very marked and should be separated first. The adhesions to the structures within the thoracic cavity are separated from below upward by approaching them through the hernial opening. By the abdominal approach this can be accomplished with little danger or injury to the abdominal or thoracic viscera, because the definite relationship of the herniated structures can be established.

In cases in which there has been considerable loss of structure or in which the muscle has been torn from its attachment to the



thoracic wall, the defect in the diaphragm should be repaired by fascia lata stabilized with linen sutures. I believe this to be the most satisfactory type of closure in all these cases. In cases of traumatic

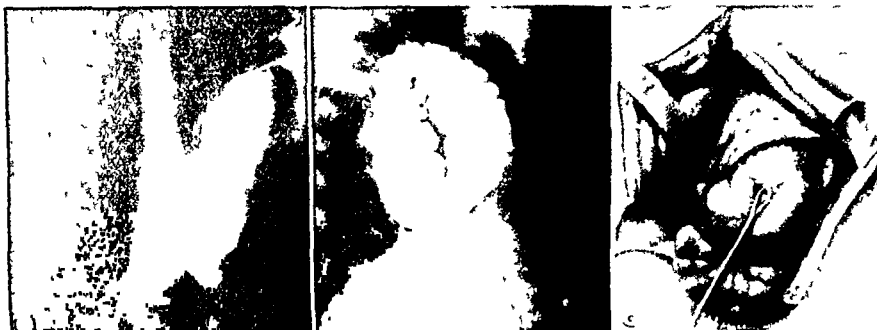


FIG. 47. *a*, patient aged 44 years. Traumatic hernia through left side of dome of diaphragm with herniation of entire stomach into left side of thoracic cavity extending to third rib. *b*, same case. Lateral view of thorax revealing large loop of colon herniated into left side of thoracic cavity and extending to third rib. *c*, same case at operation. Abdominal approach. Left lobe of liver has been separated from diaphragm. Removal of adherent stomach and spleen from hernial opening.

hernia in which the laceration is confined to the dome of the diaphragmatic muscle, it usually is advisable to repair the opening by lapping the anterior margin over the posterior margin of the opening. When possible, it is advisable to overlap the margins of the opening from 2 to 3 cm. In those cases in which the laceration splits the muscle of the esophageal ring, great care should be taken in repairing the esophageal hiatus. In those cases in which the laceration extends to the margin of the thorax and in which the attachments of the diaphragm are torn from the thoracic wall, the repair is made not only by overlapping the laceration of the leaf of the diaphragm, but by resuturing the diaphragmatic muscle to the thoracic wall. This can be accomplished by suturing the diaphragmatic muscle (Figs. 47 and 48) to the intercostal muscles between the ribs. When possible, the diaphragmatic muscle should span two interspaces, being fixed to the intercostal muscles with fascia lata and stabilized with interrupted linen sutures.

In a few instances the relaxation of the diaphragmatic muscle caused by interruption of the phrenic nerve will not be sufficient for repair of the defect. In these cases the diameter of the thorax must be narrowed by resecting the lower ribs by thoracoplasty. It is usually not necessary to resect more than a few inches of the eighth, ninth and tenth ribs at the angles.

*Inflammatory Necrosis.* One of the rarest types of diaphragmatic hernia is that resulting from inflammatory necrosis of the diaphragm caused by the rupture of a subphrenic abscess on the

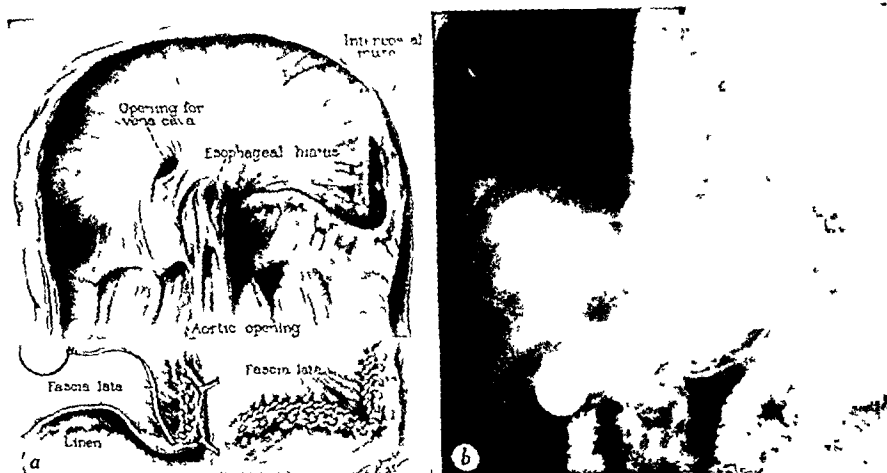


FIG. 48. *a*, same case as that represented in Figure 47. Repair of triangular rent in diaphragm with fascia lata by overlapping and suturing to chest wall after phrenicotomy. *b*, same case on dismissal. Entire stomach in normal position below the diaphragm. Pulmonary fields negative.

left side. This type of hernia may be termed a traumatic hernia. The acute abdominal condition may have preceded the diagnosis of hernia by months or years. These hernias often present a very difficult surgical problem because of the enormous number of adhesions which fix the herniated abdominal viscera to the under surface of the diaphragm as well as to the hernial orifice and at times to the under surface of the lung. These hernias usually occur in the dome of the diaphragm and do not involve the hiatus. They are repaired by overlapping the margins of the hernial orifice after carefully dissecting the viscera from the diaphragm and the margins of the opening. (Fig. 49.)

In all of these cases in which there has been a direct communication between the abdominal and the thoracic cavity, every effort should be made to reestablish the negative pressure within the pleural cavity by removing the air and by expanding the lung before the opening in the diaphragm is closed completely. In some instances this cannot be accomplished until after the rent in the diaphragm has been closed. In some cases pneumothorax may push the mediastinum and heart to the opposite side and cause marked embarrassment of respiration and circulation. In these cases it is

imperative that the mediastinum be stabilized in the midline immediately by aspirating the air from the pleural cavity with a needle until the pressure is negative. I think it advisable to make a



FIG. 49. *a*, patient aged 22 years. Rupture of left side of diaphragm due to inflammatory necrosis. Herniation of two-thirds of cardiac end of stomach, through opening in dome of left side of diaphragm, into left side of thoracic cavity. *b*, same case at operation. Abdominal approach. Stomach firmly adherent to margins of ruptured diaphragm. Opening situated posteriorly and repaired by overlapping closure. *c*, same case after operation. Stomach in normal position below repaired left side of diaphragm.

roentgenogram before the patient leaves the operating table, for the purpose of determining the amount of pulmonary expansion present.

Before closing the abdomen, the herniated viscera should be thoroughly explored, to be certain that there has been no injury to a viscus or that there are no bands of adhesions which will interfere with the function of the abdominal viscera. In cases in which there has been considerable obstruction of the large bowel, it may be necessary to perform appendicostomy or colostomy at the time of operation.

#### POSTOPERATIVE MANAGEMENT

Most patients are given a blood transfusion either during or immediately following the operation. The blood of every patient is grouped for transfusion before the operation. If the systolic blood pressure decreases to 90 mm. of mercury or less, the patient should receive a transfusion of blood. I believe it is very important to maintain blood pressure at a fairly constant level and not permit it to drop more than 20 mm. of mercury below the normal preoperative reading. I prefer the use of blood transfusions to the use of other intravenous solutions or of drugs to maintain the blood pressure.

Blood transfusions are also advisable in all cases in which the hernia is associated with blood loss producing secondary anemia.

If there is excessive mucus in the bronchi and lungs at the time of operation, it is imperative that it be removed by aspiration through the intratracheal tube used for the administration of the anesthetic agent or by the use of the bronchoscope before the patient leaves the operating table.

On removing the patient to the hospital bed which has been made warm by hot water bottles, external heat is applied to the patient by use of additional hot water bottles. Fifty-eight to 60 per cent oxygen is administered in an oxygen tent until the patient has fully recovered consciousness and is continued thereafter as indicated. After the patient has fully regained consciousness, the oxygen may be administered with a nasal mask.

Care should be exercised in the selection and amount of sedation used. This is particularly important if there is any respiratory embarrassment. Sedation should be limited so as not to decrease the respiratory function. I prefer using codeine supplemented by a small amount of morphine to relieve severe pain. In all cases in which dilatation of the stomach was present at the time of operation, intermittent or continuous gastric lavage is employed to keep the stomach empty for the first three to five days after operation.

All patients are given glucose and physiologic salt solution intravenously for three to five days until they are able to take sufficient quantities of fluids by mouth. The giving of fluids usually is started within forty-eight hours after the operation. In cases in which there has been herniation into the thoracic cavity of a large portion of the abdominal viscera over a long period, the replacement of these viscera in the abdomen causes a marked increase in the intra-abdominal pressure, which may lead to partial or complete obstruction. In cases of partial obstruction, the condition may be relieved by conservative measures, but in cases of complete obstruction, it may be necessary to perform enterostomy in order to reduce the intra-abdominal pressure and to relieve the obstruction.

In all cases in which the herniated viscera are removed from the pleural cavity, and in some cases in which the herniated viscera are removed from the posterior portion of the mediastinum, such as would be the case in herniation through the esophageal hiatus, traumatic effusion occurs in the pleural cavity. The treatment of this effusion depends on the amount of respiratory embarrassment

associated with it. In most instances the effusion is slight; it will gradually become absorbed so that special treatment will not be required. In cases in which the effusion progresses to produce respiratory embarrassment, pleurocentesis, performed one or more times, is required. In some cases empyema may develop, requiring intercostal drainage, and possibly later rib resection. In my experience empyema has rarely occurred in cases in which the hernia was repaired by the abdominal approach.

In some cases átelectasis may be caused by the lodgment of mucus in a bronchus. In most of such cases the condition will respond to conservative treatment. It may sometimes be necessary to remove the mucus by bronchoscopic aspiration.

#### REVIEW OF THE OPERATIVE PROCEDURES EMPLOYED AND THE RESULTS OF OPERATION IN 250 CASES IN WHICH TREATMENT WAS SURGICAL

The operative procedures employed in the 250 cases in this series were as follows:

In 225 cases the patients were treated by radical operation. The herniated abdominal viscera were replaced in the abdomen and the abnormal opening in the diaphragm was repaired. In 133 of these cases the diaphragm was either temporarily or permanently paralyzed preliminary to operative repair of the hernia. In two cases it was necessary to perform extrapleural thoracoplasty in addition to interruption of the phrenic nerve as a preliminary procedure to repair of the hernia. In 223 cases the abdominal approach was employed to repair the hernia; in the remaining two cases a combined thoracic and abdominal approach was employed.

In fifteen cases it was necessary to perform other operative procedures at the time of repair of the hernia. In three cases gastric resection (Pólya type) was done, in one case for gastric ulcer at the lesser curvature of the stomach and in two cases for carcinoma of the pyloric end of the stomach. In three cases posterior gastroenterostomy was performed, in one case for high gastric ulcer involving the lower end of the esophagus and in two cases for a large duodenal ulcer causing almost complete obstruction of the pyloric end of the stomach. In five cases splenectomy was performed. In all of these cases the spleen was firmly adherent to the margins of the opening and to the thoracic side of the diaphragm. Trauma associated with its removal from the hernial orifice and the diaphragm necessitated the removal of the spleen in three cases and in two cases the spleen

was removed because of tuberculosis. In one case appendectomy was performed for subacute appendicitis and in one case appendicostomy was performed at the time of operation because of obstruction and marked dilatation of the colon.

In eleven cases moderate shortening of the esophagus was associated with the hernia. In ten of these cases the diaphragm could be sutured entirely above the stomach after the diaphragmatic muscle had been paralyzed by interruption of the phrenic nerve. In one case a small portion of the cardia was incorporated in the closure of the hernial orifice.

TABLE 11

## SURGICAL PROCEDURES AND OPERATIVE RESULTS IN 250 CASES

Radical repair of defect in diaphragm.....	225
Approach: Abdominal, 223; thoracic, 2	
Preliminary interruption of phrenic nerve.....	133
Preliminary extrapleural thoracoplasty.....	2
Operations in conjunction with repair of hernia:	
Gastric resection for gastric ulcer (1) for carcinoma (2).....	3
Closure of perforated gastric erosion (2) (total erosions, 23).....	2
Gastroenterostomy for gastric ulcer (1) for duodenal ulcer (2).....	3
Splenectomy for tuberculosis (2) for injury (3).....	5
Appendicostomy for obstruction.....	1
Appendectomy for appendicitis.....	1
Interruption of left phrenic nerve (hiatus hernia); palliative, 7; therapeutic, 18....	25
Total patients subjected to operation.....	250
Recurrence of hernia according to type subjected to operation:	
Traumatic hernia, 0; congenital defect, 0; esophageal hiatus, 7	
Recurring esophageal hiatus hernias (7)	
(Roentgenologic diagnosis without recurrence of symptoms, 4)	
(Roentgenologic diagnosis with recurrence of symptoms, 3)	
Repair of recurrent hernias, 2	
Operative deaths, 10 or 4 per cent	

Twenty-five patients with esophageal hiatus types of hernia were treated conservatively. In these cases interruption of the left phrenic nerve was done as a palliative or therapeutic measure; in seven of these cases, it was the only procedure contemplated, as radical operation was contraindicated, and in the remaining eighteen cases the procedure was in the nature of a therapeutic test. It may be necessary to perform radical repair of the hernia in some of these cases later to obtain complete relief of symptoms.

There were ten deaths, or a mortality rate of 4 per cent, following operation; seven deaths occurred in cases of esophageal hiatus hernia, two in cases of traumatic hernia and one in a case of hernia

through the pleuroperitoneal hiatus. Nine of the deaths were due to pulmonary congestion or pneumonia with respiratory and cardiac failure; one of these patients had cardiac disease and one had cardiorenal disease prior to operation. One death was due to cerebral embolism. (Table II.)

Of the 215 cases in which patients recovered from radical repair of the hernia, a small recurrence has developed subsequently in seven of the esophageal hiatus type. These recurrences occurred from three months to five years after operation. Of these seven cases of recurrence, in four cases the recurrence was small and it was recognizable by roentgenographic examination only as there was no definite recurrence of the former symptoms to indicate its presence. In three cases there was a moderately large recurrence of the hernia discovered by roentgenologic examination and definite recurrence of the patient's symptoms. In two of these cases the recurrence followed an attack of an influenzal type of pneumonia which occurred three and five months, respectively, after operation. The pneumonia was accompanied by severe attacks of coughing which could account for the recurrence. In these two cases the symptoms became severe enough to require a second repair of the hernia, which has been done. Following the second operation there has been no further recurrence clinically or roentgenologically. In the third case there is no known cause for the recurrence of the hernia. The patient continues to have moderately severe symptoms and will probably ultimately require a second repair of the hernia.

There were no recurrences of the hernias in any of the traumatic or congenital types of hernia due to structural deficiencies of the diaphragm.

Of the 215 patients who recovered from radical repair of all of the different types of diaphragmatic hernia, 212 were relieved of symptoms. All patients have been examined roentgenologically from six months to a year after operation and at periodic intervals since that time.

# The American Journal of Surgery

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A PRACTICAL JOURNAL BUILT ON MERIT

## EDITORIALS

### WHAT IS MINOR SURGERY?

FOR the past few years there has been a constant demand from the medical and legal professions and the judiciary for a definition of minor surgery. Attempts have been made to differentiate between major and minor procedures by hospital authorities mainly for the purpose of financial classification of the patient. There is no definite demarcation between minor and major procedures. This differentiation is governed by the type of hospital. In order to reach a definition of minor surgery various groups were consulted for their interpretation. The following are some of the accepted definitions of minor surgery:

The Board of Regents of the University of the State of New York adopted the following on July 28, 1939: "The phrase 'minor surgical procedures,' as used in the law, shall be construed to include all surgical procedures excepting those involved in incision for: the opening of a natural body cavity, the removal of benign or malignant tumors, bone fractures, the amputation of an extremity or an appendage, the removal of any gland or organ or part thereof, or plastic surgery of the human body."

In the preface of Dr. Frederick Christopher's textbook on minor surgery he gives the following definition: "Minor Surgery is the surgery which has a low mortality; which requires but few assistants; which

generally is done in the hospital out-patient department or in the office. It includes the large majority of surgical cases; the everyday surgical conditions. *All minor surgery potentially is major surgery; often a distinction cannot be made.*"

Doctor T. R. Ponton, Editor of *Hospital Management*, in December, 1937, after studying the subject, stated: "There can be no rigid definition of major or minor surgery. In fact, it is very doubtful if the terms are not misnomers except from the financial point of view. Looking at the question from the professional aspect, it must be acknowledged that there are few operations which require so slight a degree of skill in their performance as to warrant the use of minor classification. When the risk to the patient is considered, the use of the term major must be applied to all surgery in which, for any cause whatever, there is a serious risk to life or grave danger of disability, whereas in the minor case, these hazards are slight."

Doctor MacEachern in *Medical Records in the Hospital*, lists the five points which classify an operation as minor:

"a. The abnormal condition which indicated the operation is such that, in itself, it constitutes no serious hazard to the life of the patient.

"b. The patient shows no other abnormality which, added to the condition



indicating operation, would constitute a serious hazard to life.

"c. The operation is not of an extensive or complicated nature and requires only simple equipment, a minimum of assistance and a short period of time.

"d. The surgeon is sufficiently trained and experienced in the particular type of operation to be performed to obviate the addition of any hazard to the life of the patient.

"e. If an anesthetic is necessary or advisable, it should not be of a deep and lasting nature, should be selected with care and should be administered by an anesthesiologist who is skilled in administration of the particular types of anesthesia."

It is apparent from the foregoing interpretations that there is no minor surgery. A superficial infection of the nose may terminate in meningitis or brain abscess (example cited by *Medical Times* of October, 1938). Any break in the continuity of the skin may end in an infection of the blood stream. A so-called minor procedure in a diabetic patient may terminate in an extensive operation and possibly death. A simple tonsillectomy in hemophiliacs may result in a serious risk to life. Anesthesia for minor procedures is also responsible for a considerable number of fatalities. A simple spontaneous delivery, forceps or version may lead to puerperal sepsis, rupture of the uterus and other complications. A simple curettage of the uterus may cause perforation with possible hemorrhage or peritonitis. Again we must not lose sight of the surgeon's skill in the operative

procedure. The time element, the knowledge of the special field of surgery and the individual technical ability may sometimes make a minor procedure a major operation.

The only possible distinction that can be made between minor and major surgery has to do with the cost of hospitalization. This is arbitrary and depends upon the respective locality and type of hospital administration. When the risk to the patient is considered, surgery is surgery, and any attempt at definition of a minor procedure is entirely out of order. I fully agree with Dr. Hubert A. Royster, who states, "that the term minor surgery should be eliminated from the nomenclature." Of 104 surgeons whom Dr. Royster consulted only one disagreed with this opinion. Personal communications with the respective American Boards are in accord with this idea.

It is impracticable, therefore, to classify operations as major or minor. There is no authoritative classification of this nature published except as a guide to the hospitals in the determination of hospital costs. We do not invoke the latter when the purely surgical interest of the patient is considered. In the interest of the public it becomes a necessity for the medical profession at large to make an attempt properly to classify procedures so that practitioners of medicine with limited privileges can become acquainted with their limitations, and that the judiciary can refer to some authority when interpreting the law. It is, therefore, our duty to supply such a classification.

VINCENT P. MAZZOLA, M.D.

## WHO KNOWS?

THIS special number is the result of many requests that we again publish short, practical articles on so-called minor surgical procedures. In the foregoing editorial the reader will be impressed with the fact that the term, "minor surgery," is a misnomer. Much has been written on this subject, but to date a true definition has

not been given. In this, the third special issue on minor surgery published by us, the term has been used for the want of a better name.

Physicians have a loose idea as to what constitutes minor procedures, but the Courts often have to arrive at a definition and so far have looked to us in vain to

supply their want. Roughly, any surgical procedure is major unless the operator has had an adequate medical training (graduate of a recognized school of medicine). In other words, only one with a medical degree and licensed to practice has a legal right to do surgery. In this sense, surgery covers the field from the most simple to the most involved procedures. The cultist and member of a healing field outside of medicine, as it is legally defined, cannot do even the so-called minor procedures, because he has not had the basic training and surgical background. To the doctor of medicine with the legal right to do surgery, the thing resolves itself down to the ability and limitation of the individual. The recognized gynecologist, for example, looks upon a diagnostic curettage as a minor operation.

To the general practitioner with scant experience in this field it looms as a major operation.

For the Court's benefit we would say that any procedure that calls for incision, excision, suturing, injection or an anesthetic of any type in order to make the procedure possible, is not minor surgery. In this case all surgery is major surgery. In a later issue Dr. Mazzola will list the various so-called minor procedures as given to him by a representative of the various Boards in the surgical specialities. A few years from now, another issue similar to this may be published on minor surgery. If anyone has a title for it—an apt title—we should appreciate having it.

T. S. W.



# ORIGINAL ARTICLES

## THE TREATMENT OF INTRACTABLE PAIN

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THE term, intractable pain, is frequently used, and it seems necessary that a definition should be formulated so that when intractable pain is mentioned we may know what is meant. Intractable pain may be regarded as a pain which requires the constant administration of sedatives and narcotics, such as morphine, etc., without any continued ameliorating effect. It resists all efforts of cure, becomes a scourge and a torment to the afflicted person and a problem of worry and concern to the attending physician. It usually keeps the patient awake at night and so disturbs mental and physical reactions that the sufferer is unable to carry on his usual work and becomes an early victim to disease and misfortune. The degree of pain and criteria of the effect of treatment may be judged by the afflicted person's ability to enter spontaneous sleep without sedatives.

If time and a more systemitized investigation is necessary to obtain a better conception of the causative factors, the patient with severe and intractable pain should be hospitalized until the attending physician is sure of the actuality and the degree of the pain and its relationship, if any, to physical changes and bodily functions. This understanding is necessary because in the uncertainty and turmoil of present day conditions, the psychic stamina of many individuals seems to be so reduced that abnormal and bizarre reactions occur to weak and otherwise unimportant stimuli. A disturbed psyche frequently is associated with a craving for sympathy so that in many instances, when cravings are un-

appeased, the patient's impressions are sublimated and are ordained into sensations of pain. In such conditions, narcotics and sedatives are sought as a means of relief. Subconscious fear of disease such as cancer, etc., will also lower the central threshold for sensory impressions and lead to pain.

Because of its hold on consciousness and its reflex devastating effect, surcease from pain is essential in the therapeutics of several diseases, such as coronary heart disease and pneumonia. In such cases sturdy efforts should be made towards its relief.

A clearer concept of the factors involved in the production of pain and the measures useful in its relief is of importance when we consider the many times that pain has been the unrecognized pernicious factor involved in horrible judgments leading to actions pregnant with misery and distress. Personal and national calamities at times may be the result of the hidden motivations evolved by the abnormal processes of a mind distorted by pain. It is self apparent that headache, throbbing with the thumping of demons working in disordered clamor as was so clearly defined by Hogart, is not conducive to clear thinking and lucid decision.

It is reasonable to suppose that pain is apt to produce a state of mind which is unfavorable to the making of elemental decisions and it is also conceivable that the distress caused by intractable pain may lead to unmerited determinations in which the psychic equivalents of sadist desires are

hidden. These hidden motivations act as compelling factors in the formulation of actions and clarify deeds which otherwise are unexplainable. Headache alone has led to disaster and it is said that the hemorrhoids of Napoleon lost the battle of Waterloo.

The significance and the importance of pain as a factor in diagnosis is not to be minimized nor, on the other hand, are we to be deceived by misleading statements of the severity and quality of the pain. We should not be influenced by complaints from the patient as to its intensity and constancy. If the appearance and complacency of the sufferer belies the emphasis placed by him on his anguish and distress, we must be cautious in our evaluations but should not discount all the statements of the patient.

In many cases it may be necessary to determine if any pain is present. Should the examiner be convinced of its actuality, it is his duty to evaluate its severity and know how far he can proceed in any particular case on the assumption that pain is feigned. If not actually imagined, pain may be a psychic termination of the activity of a mass of subconscious impressions, or, in a vicarious manner, it may be the result of correlated subconscious reactions constantly striving for acknowledgment in the realm of actuality.

The fear component with its acute apprehensive expectancy may be so active that the least touch or physical reaction which penetrates to the sensorium will instantly produce an acute sensation which may be misinterpreted as painful. These patients should be assured and convinced by logical reasons by a physician who has gained their confidence—and confidence is not obtained by antagonism—that their sensations while real have become magnified and at times may actually be mistakenly interpreted by their own apprehensive fears.

Patients of the character described above, who are subject to intensive complaints of pain, may not even be influenced by large quantities of narcotic drugs such as morphine. The acute manifestations may

be overcome by central physical depressants as bromides, barbiturates or by psychotherapy. Great care should be exer-

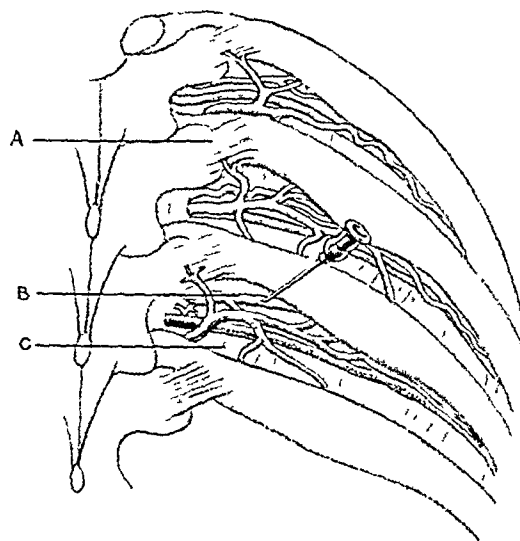


FIG. 1. This figure shows the method of injection into the intercostal nerves for the relief of pain in intercostal neuralgia. A, ligamentum tuberculi costali; B, intercostal nerve; C, membrane intercostales posterior. The figure reveals the three intercostal spaces with their contents, the nerve, the artery and the vein. The external intercostal muscle has been removed. The posterior intercostal membrane and the internal intercostal muscle are intact.

cised by the physician that the increased interest which is directed towards the patient's attitudes and symptoms does not so engraft these attitudes and symptoms that they become fixed and occupy the mind and consciousness of the patient to the exclusion of other signs and symptoms more indicative of the pathologic lesions from which he is suffering.

In the treatment of individuals such as these, the absolute need is a change in the attitude of the patient toward himself so that he can be led as far as possible into a state of sensory abnegation in which physical reactions are not stressed in psychical terms of his own physical integrity. On the contrary, psychical exaltation of his ego into a phase of mental exaltation will expel harmful impressions from his consciousness. This should be the aim of his physician.

In such persons, purposeful mental and physical activity with definite and planned

design must be substituted for inactivity or abnormal activity of mind and of body. An attempt should also be made to correct

purpose of the physician or for release from misery of the affected, for the medical consultant to tell the suffering individual that

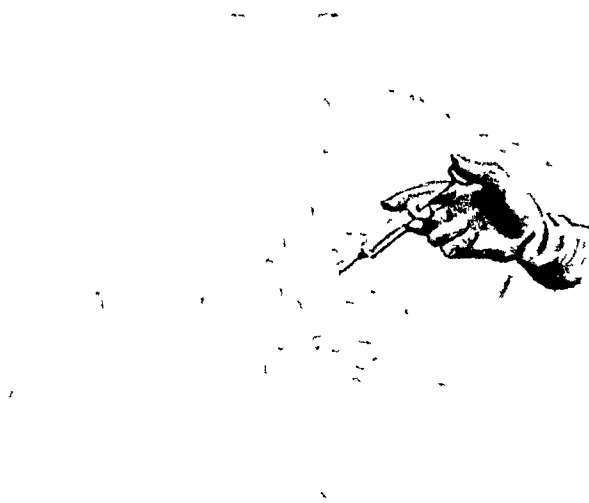


FIG. 2. Illustration shows method of insertion and direction of insertion of needle in paravertebral injection.

the disturbed mental state by improving environmental productive factors.

In all cases of intractable pain the patient-quotient as a factor in the production of the pain must be evaluated and all pernicious influences, instrumental in its production should be eliminated. When this is possible, intractable pain may gradually disappear.

It is of extreme importance for the welfare of the patients with intractable pain that the medical attendant never become irritated nor should he be peeved if his efforts to ameliorate the patient's complaints are unsuccessful; neither should he regard himself as free to express doubt of the results of his treatment nor should he show irresolution in the handling of patients complaining of pain. Any confusion or apparent lack of confidence on the part of the medical advisor usually is reflected by redoubled exaggeration and intensification of the patient's symptoms.

As a preliminary to more direct treatment, allergies, anxiety states, etc., should be sought and eliminated. When a person complains of pain which interrupts his daily activity and disturbs the repose of his sleep, it does not suffice for sincerity of

his pain is really not present but is a figment of his imagination. Even though the doctor may be sincere in the honesty of such a judgment, the patient knows that in many cases it is, as he says, "a lot of hooey." He is more than dimly conscious that frequently the doctor may be burying his head in the folds of his own ignorance. The patient himself knows that he has pain and that it is real, because he feels it and will not believe anyone who claims that he has no pain, and that is the point of this discussion. It makes no difference to the patient whether his sensation of pain is due to imaginary projections or is the result of central, complex and hidden causes, as long as he feels it, the pain is real. Therefore, in every case in which pain is perceived, it is necessary that immediate measures be taken by the medical attendant for its relief. Irrespective of how intelligent or how cooperative the patient may try to be, he is more insistent in his clamor for the immediate relief of his pain than he is for the discovery of its cause.

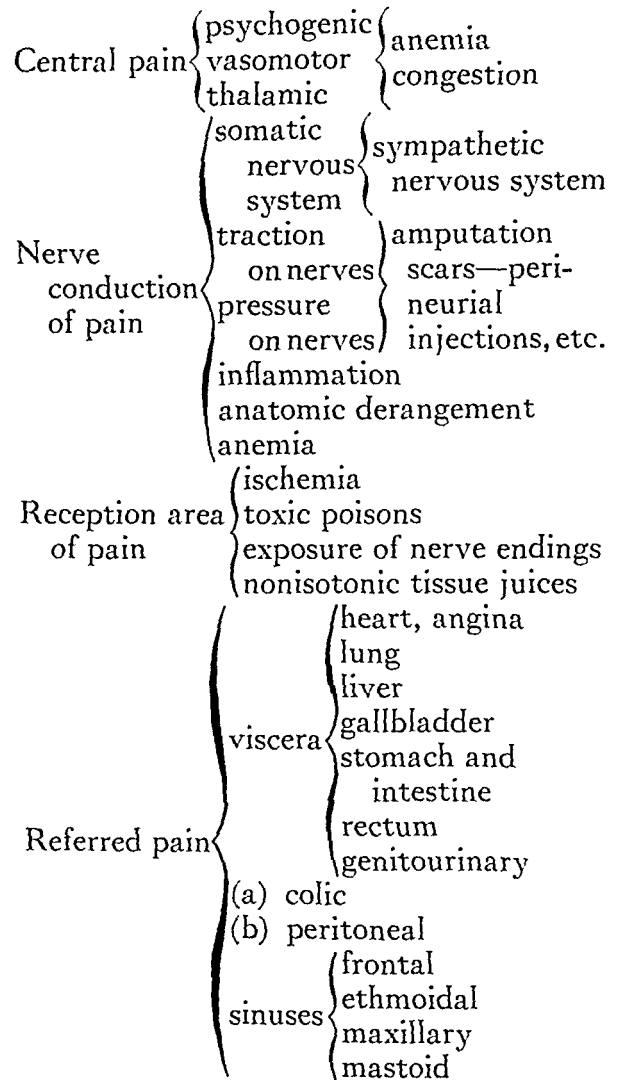
For this reason, while investigations are being continued to determine the cause of the pain, measures should be instituted for its relief. If a pain is intractable to treat-

ment or if it does improve with treatment and then returns, it means that the factors causing the pain are still operative, or that the recuperative processes instituted by the patient against these factors are not constant. However, when the pain cannot be relieved or returns after temporary relief, the physician should not permit himself to be so influenced by the clamor and the pleadings of the patient for relief, as to be stampeded into using means and remedies which are unjustified. He should balance therapeutic benefits against danger to life, the production of serious anatomic defects or the loss of function which would be disabling and unbearable in its distress. This is all the more significant because in some cases as time goes on and ameliorating treatment is applied, it is surprising to note that the pain may tend to disappear or change to another type which is more amenable to treatment. In due time the cause of the pain will be established and the pain can then be relieved. In every case, haste should be made slowly. In many instances, strange as it may seem, irrespective of the fact that the causes of the pain are not discovered nor corrected, the pain itself gradually disappears, possibly because in some manner the measures instituted for the relief of pain may indirectly have removed or modified the cause of the pain.

In the quest for the causative factors producing the pain, we should remember that pain may be due to derangement in the central sensory pain reception areas or to disturbances in the conducting or perceptive apparatus. The onset and the continuation of a pain should be regarded as the result of maladjustments in the mechanical, chemical or functional activities of the various organs of the body.

Pain of central perceptive origin may arise in the cerebrospinal central nervous system or be a result of derangement in the complimentary sympathetic nervous system either in the ganglia, the conducting apparatus or the cerebral sympathetic nerve centers (tuber cinereum).

Intractable pain may occur in any of the following components:



Pain of central origin may be either *psychic* or *organic*.

*Psychogenic* pain is subjective, in that it arises without objective irritation. It is the result of psychic maladjustment. The psychopath as a rule is so possessed by his own introspective conceptions that he is indifferent to exterior influences. Such an individual does not resent the imputation that the pain of which he complains does not exist, and in many instances he is apathetic and is not interested whether the findings of the examining physician do or do not corroborate his complaints. The malingerer, on the other hand, is very anxious that the

symptoms and reactions elicited by the medical examiner support the pattern of the symptoms he has elaborated.

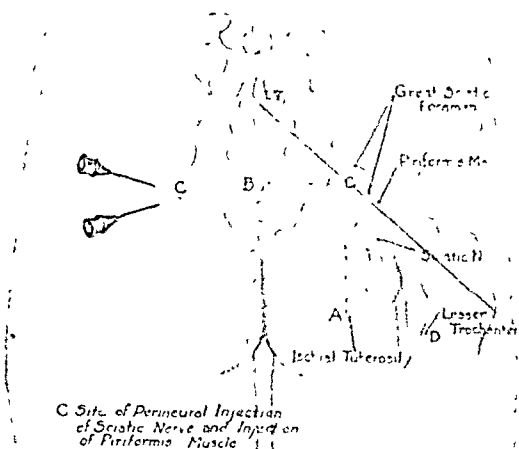


FIG. 3. Technic of perineural injection of the sciatic nerve as it emerges through the greater sciatic foramen. The intersection of the dotted lines and the line drawn from the femoral trochanter to the fifth lumbar spinous process indicates the point at which the needles are introduced. (From Haggart, G. E. *Sciatic Pain*. *J. Bone & Joint Surg.*, 20: 851, 1938.)

This indifference which the subject with psychogenic pain has to the results of physical investigations is due to the fact that the pain of which he complains is of central origin and the factors inducing it are not changed by peripheral sensory impressions. At times, in such cases, it is difficult to determine whether pain is actually present.

If pain is actually present, it will be accompanied by one or more of the following conditions: Elevation of blood pressure, motor reflexes causing contraction of muscles in or over the painful area, changes in facial expression, dilatation of the pupils, pallor and syncope, increasing rapidity of the pulse and more rapid and shallower breathing.

*Functional changes* in the central nervous system instrumental in causing pain may be due to vasomotor disturbances which produce a congestion or an anemia of the brain tissues. Pains due to circulatory disturbances are usually manifested in the form of headache. If headaches are persistent and constant in their intensity and

location it is an indication that the causative factors are persistently active. When we have this information, it is necessary to look for such factors.

Headache due to cerebral hyperemia is associated with a flushed face and hot skin. Sitting or standing will relieve the headache; declining in a prone position will increase it. In this condition drugs acting upon and stimulating the sympathetic nervous system will correct the oversupply of blood, reduce the turgidity of the tissues and decrease intracranial pressure.

The opposite is true in vasoconstrictor headaches, the best example of which is migraine. Almost acting as a specific in this condition is acetylcholine which paralyzes the sympathetic nervous system and thereby allows the peripheral vessels to dilate and increase the circulation. Ethylchlorine inhalations or inhalations of amyl nitrite have somewhat the same effect but are very evanescent. A simple treatment which many years ago I began to use in any kind of headache, due to almost any cause, is a reduction of the skin temperatures of the affected areas by the application of ice or of ether dropped on or sprayed on the skin. Spraying of the skin area to which pain is referred with ethyl chloride is also effective. The dropping of ether on the skin with evaporation, which is increased by blowing with a fan, has also proved effective in the headache following spinal anesthesia. It appears that desensitization of the skin areas in which the pain of headache is felt also has some indirect influence in alleviating the cause of the headache, for after the effect of the cold on the skin has subsided, the headache may not return. The pain of headache can in most instances be relieved by the subcutaneous injection of novocaine solution into the tender skin areas. Chronic headache due to systemic causes must be treated by correcting the systemic derangement such as anemia, toxemia, etc.

*Head Pain of Organic Origin.* If the pain is due to a lesion in the central pain perceptive areas, as in the thalamus, the

impossibility of relief has been repeatedly demonstrated.

Intractable head pain due to increased

*Dose.* The initial intramuscular injection is 1 cc. or 5 mouse units. This dose is followed on each succeeding day or every

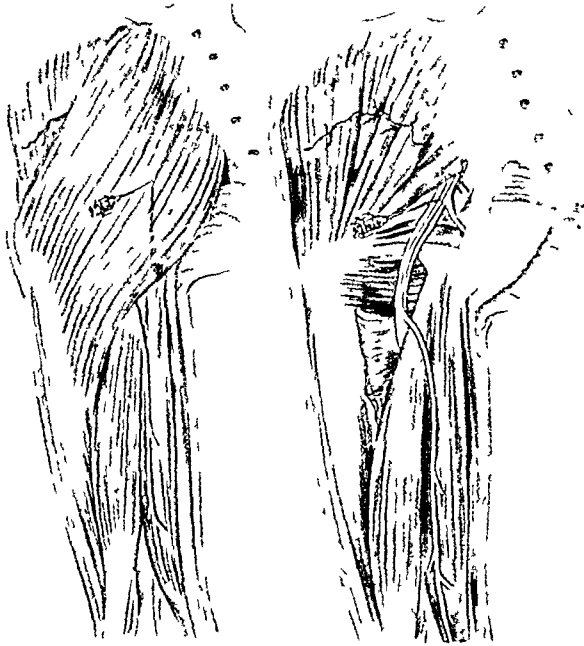


FIG. 4. Diagram showing site of injection and approximately the area which the tip of the needle penetrates for injection of sciatic nerve at the greater sciatic notch

intracranial pressure, such as would be produced by intracranial tumors, are extremely difficult to relieve. Acetanilid or its combination with phenacetin has been of service. Morphine sulfate, even though it is habit forming, is justified. Migraine frequently is associated with and is increased by high blood pressure which should be reduced. Ergotamine tartrate is used for this purpose; all reflex causes for headache should be eliminated.

*Drugs or Other Substances Acting on the Cerebrum.* These drugs must reduce the receptive sensitivity of the cerebral cells receiving the pain producing impulses. One of these substances which recently has been greatly extolled is cobra venom. There has been considerable controversy over the efficacy of cobra venom in the relief of pain. According to Macht,<sup>1</sup> the action is central upon the cells of the cerebrum. It has been recommended particularly in cancer.

other day by at least 50 mouse units. As soon as the subjective symptoms decrease, the dosage is reduced.<sup>2</sup> The sites of injection are alternated, and no effect is expected until five or more injections are given.

Cobra venom was injected subcutaneously at intervals of two days and in doses up to 25 mouse units in ten patients with advanced genital cancer. In two cases there was complete cessation of pain. In the other eight, there was a lessening of the pain in varying degrees. No effect was noticed, especially gastrointestinal symptoms. The conclusion is drawn that cobra venom has no advantages over the ordinary analgesics, especially morphine.<sup>3</sup>

Cobra venom has also been used in the treatment of the pain of arthritis, osteoarthritis, tabetic crises, uncontrollable neuralgia, sciatica, tic douloureux and myofascitis. Other central acting anesthetic agents which are better known are



morphine, the barbiturates, the bromides, etc.

morphine because of the fear that a habit may be formed; but, contrary to what is regarded as the usual result, it has been my

The abatement of intractable pain by



FIG. 5. Diagram showing the location and direction of the needle for injection of the brachial plexus. A, omohyoid muscle; B, transverse cervical artery; C, brachial plexus; D, subclavian artery; E, scalenus anticus; F, sternomastoid muscle; and G, internal carotid artery. (From Behan, R. J. *Cancer*. P. 490. St. Louis, Mo., 1938. C. V. Mosby Company.)

limiting or abolishing the perceptive centers in the cerebrum by narcotizing drugs is to be condoned only when all other means have been tried and have been found ineffective. It is especially to be recommended that during the period when attempts are being made to determine the cause of the pain, the pain itself should be controlled by means of drugs (narcotic or sedative), mechanical measures producing rest or alleviation of muscular or ligamentous strain, localized injection of desensitizing substances or surgical interruption of the pain conducting fibers.

Drugs acting centrally on the pain perceptive centers in the brain should be used with extreme caution. Such drugs are usually opium derivatives, such as morphine, pantopon, dilaudid, etc., or derivatives of cannabis indica.

To all patients with intractable pain there is a universal disinclination and hesitancy of the medical attendant to give

experience that when pain for which morphine is given ceases, the craving usually is corrected. In fact, the craving for morphine frequently represents the desire of the subject to remove himself from the sphere of the disagreeable to the dreamland of the unreal. In some instances this may be desirable. In all cases care should be exercised in prescribing morphine, for no one can tell whether the moral stamina of the one to whom morphine is given is sufficiently sturdy to voluntarily correct his tendencies and desires, when the cause for which the morphine is given is removed.

In selecting narcotic drugs, the nonhabit forming ones should be chosen. In this choice care should be exercised that drugs to which the patient is allergic are not given, or that drugs such as aminopyrine should not be too long continued without a close inspection of the morphology of the blood (agranulocytosis is an indication that the drug should be stopped).

In the class of drugs most reliable in producing central sedation in long continued and intractable pain, are the bromides and the barbiturates. From his investigations, Barnett Alpert<sup>4</sup> concluded that bromides are preferable to any barbiturate; they are not habit forming and do not produce tolerance. Phenacetin and amidopyrine are also useful as is chloral hydrate which may be used alone or in combination with the bromides. Proteins, heat and fever therapy have in many instances been found valuable.

Vitamin deficiency, especially that of the B complex, has been considered a factor in increasing the sensitivity of tissues; for this reason, B complex should be tried in all conditions where pain occurs from weak and ordinarily unproductive stimuli.

Vitamin deficiency, especially the deficiency of the vitamin B complex, also is frequently a factor in the occurrence of peripheral neuritis (beriberi), the neuritis of pregnancy and the neuritis due to alcohol, lead, diabetes, etc. Vitamin B<sub>1</sub> (thiamin chloride) or the B complex should be given to every patient suffering from intractable pain. In the treatment of the pains of tabes dorsalis, good results from the use of vitamin B<sub>1</sub> were obtained by Metildi.<sup>5</sup>

*Spinal Cord Lesions.* Lesions of the spinal cord producing pain are not amenable to nonoperative treatment. In lesions peripheral to the cord involving the posterior roots or the ganglia, or sensory nerves distal to the roots and ganglia, a subdural injection of alcohol is of value.

*Drugs Acting upon the Synapses.* Calcium in the form of gluconate has been used as a means of controlling pain. Calcium gluconate for pain in cancer was first advocated by the author in a paper read before the Buffalo Academy of Medicine in 1926, and one read a year earlier before the Allegheny County Medical Society, Pittsburgh Medical Bulletin, June 20, 1925.<sup>6,7</sup>

In a discussion of E. E. Downs' paper<sup>8</sup> on "Care of the Cancer Patient" at the

thirty-seventh annual meeting of the American Roentgen Ray Society at Cleveland, Ohio, 1936, Dr. Kenneth D. A. Allen,

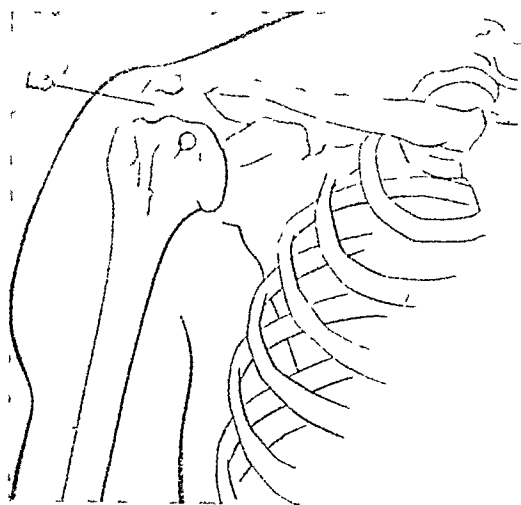


FIG. 6. Needle, 1, is entered directly anteroposteriorly, to reach the head of the humerus the projection of which is easily determined by palpation. Needle, 2, is entered lateromedially, below the external border of the acromion, in the hollow which separates the acromion from the head of the humerus; it reaches the subdeltoid bursa. (From Atlas of 25 Points for Local Injections. 2nd Edition, p. 15. Paris, France. Midy Laboratories.)

of Denver, Colorado, agrees with Dr. Downs that calcium gluconate and dilaudid are very useful. Calcium gluconate is of value in the control of the pain. Dilaudid in small doses is of great benefit. It may take the place of morphine and will be effective in smaller doses.

Acetylcholine, which acts upon the synapses, in doses of 0.1 to 0.2 Gm. is of great benefit in the condition called causalgia, in which the resulting neuralgiform pain is out of all proportion to the slight injury to the nerves of the extremities, especially the median, the cubital and the internal popliteal nerves. In such cases it may be necessary to continue daily injections of acetylcholine in order to control the pain. In patients with arteriosclerosis the improvement is at best only temporary.<sup>9-11</sup>

In preference to drugs and other narcotizing substances, reliance should be placed as much as is possible upon accessory

methods of treatment which are directed towards removing the cause of the pain. In toothache the pain is corrected by proper

is not to be recommended as it is apt to create a false sense of security. In pain of neuritis and neuralgias, and pain of cryptic origin, vitamin (B complex) should be given and fever and protein therapy should be tried.<sup>12</sup>

*Nerves and Nerve Terminals.* Drugs acting on the receptive sensory end terminals of the pain conducting pathways may be used to control intractable pain. Most of our efforts to control the local reception of pain impulses have been restricted to the direct application of nerve blocking drugs in proper solution. Of these the first to be used was cocaine, but accidents and even death has followed its use; so that when novocaine (procaine, one seventh as toxic) was introduced, it quickly supplemented the more dangerous drug. If a long continued effect is sought, the anesthetizing agent may be dissolved in oil.

The pains due to toxic absorption are the result of irritation of the terminal sensory receptors by substances in the tissue juices of the painful region.

It is known that increase in the hydrogen ion concentration of the tissue juices increases nerve excitability; a decrease of hydrogen ion concentration decreases excitability. If a change in the composition and chemical reaction of environmental tissue juices occurs, it may be regarded as the possible cause of any pain which may be present. The tissue juices, if of a lowered pH, may be restored to a normal reaction by deep injection of a 0.5 per cent sodium bicarbonate solution into the affected tissues. Such an injection is of value and may be tried especially if the intractable pains occur in muscle tissues. It is also significant that decrease in osmotic pressure diminishes excitability, and increase in osmotic pressure increases it. Histamine dehydrochloride—1 ampule of 1 cc. containing 0.5 Gm. of histamine dehydrochloride in isotonic solution with a hydrogen ion concentration of about 7.0 may be used as a corrective for pain in acute and chronic myalgias and in arthralgias due to acute and chronic peri-

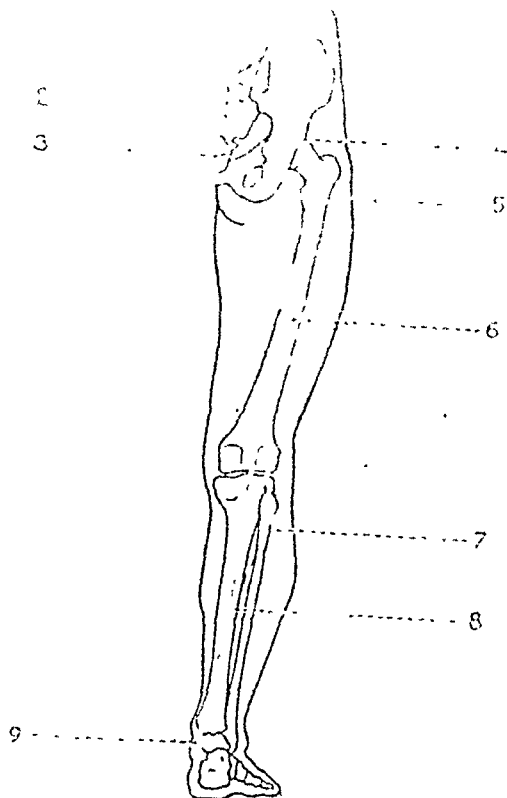


FIG. 7. Points at which injection of the analgesic solutions should be made. It is in these areas that local points of tenderness are present in the sciatic nerve involvement.

1. Infiltration of the superior roots of the sciatic nerve ( $L^4$  and  $L^5$ ) by paravertebral injections.
2. Infiltration of the inferior roots of the sciatic nerve (sacral roots) by presacral injection.
3. Infiltration of the inferior roots of the sciatic nerve (sacral roots) by epidural injection.
4. Infiltration of the sciatic nerve at its exit from the great sciatic foramen.
5. Infiltration of the sciatic nerve at its entrance into the ischio-trochanteric notch.

dental care. Correction of the pain of pleurisy is obtained by fixation of the chest by strapping with adhesive. In backache, better posture is of great value, etc. In angina pectoris, restriction of effort is necessary. In acute indigestion, gastric lavage produces immediate relief. In infections, the local application of heat or cold in the form of compresses, etc., may be used. In earache, mild anesthetics in solution in oil can be dropped into the ear, but

arthritis, etc.<sup>13</sup> Radiations derived from radium decrease excitability of sensory nerve terminals and then destroy it. In this manner pain is relieved.<sup>14</sup>

According to Wiggers, control of pain may be induced by reduction of the conductivity of sensory neurons by (a) pressure (mechanical compression of a sensory nerve which blocks motor axons before it blocks the sensory fibers in the order of fibers which transmit pressure sensation, then colic pain, then heat and then pain). The pressure should be considerable for slight increase in the excitability of axons may be produced by mild prolonged pressure. (b) Cooling which reduces the excitability; warmth, increases excitability. (c) Chemicals and narcotics (novocaine) applied over a segment of a nerve will hinder or absolutely stop the passage of sensory impulses, depending on the strength of the solution. If the impulse passes the narcotized segment, it again assumes its normal intensity.<sup>15-17</sup>

Neuralgias are due to some change in the sensory nerves, which render them so sensitive either in the conduction of pain impulses or in sensory terminal reception that they react with a sensation of pain to minor stimuli. Adhesions are frequently present between the nerve bundles and the nerve sheath; these have been found especially in neuralgias of the larger nerves, as the sciatic, and have been regarded as the cause of the pain which was present.<sup>18</sup> It is not difficult to visualize the disturbing effect which such adhesions would have during locomotion, when changed relationship, due to contraction of muscles and the consequent pull and drag upon the nerves, will cause irritation and pressure.

Because of the ulterior and devastating influence that pain has on moral and physical behavior, it is necessary that neuralgias be overcome as quickly as our means and knowledge will permit. If the pain is not amenable to the usual drugs such as aspirin and the coal tar derivatives, aminopyrine 0.75 Gm. every third hour or

acetylsalicylic acid, 0.75 Gm. every third hour may be given; the two may be combined. Dry heat, diathermia, hyperthermia,

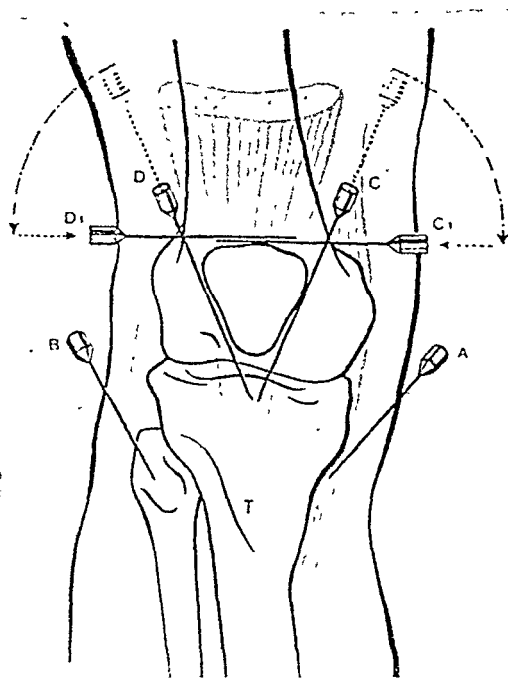


FIG. 8. The points of injection around the knee joint. These points vary depending on the localized tenderness. The solution is injected into the most tender areas. (From Atlas of 25 Points for Local Injections: Thiodocaine. 2nd Edition, p. 13. Paris, France, Midy.)

application of the short wave, local inunctions of nupercaine, salicylates, phenol, menthol, etc., and finally direct injections of analgesics around and even into the nerve should be tried. Injection of analgesic or anesthetizing agents is most effective at the point where the nerve passes through deep fascial layers to become superficial.

One of the most severe and disturbing neuralgias is that of the fifth nerve (trigeminal neuralgia). The pathologic condition producing this condition is more of the type of a radiculitis or ganglionitis than it is of a neuritis and produces the most agonizing pain. Usually it requires destruction of the ganglion of the fifth nerve or section of the posterior sensory roots of the ganglion to relieve the pain. In some cases, however, peripheral desensitization may be of particular value especially when the neuralgic attack is

precipitated by peripheral irritation. A much used desensitizer of the sensory fibers is trichorethylene, a few whiffs of which

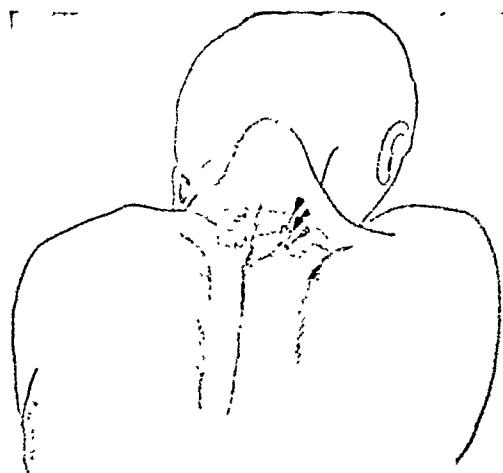


FIG. 9. Points of insertion of the needle, showing the change of direction after the point of the needle has passed the bony resistance of the first rib, or the transverse process of the vertebra. It is then inclined to an angle of 20 degrees to the perpendicular and is inserted to a further distance of 3 cm., or until the resistance to the further insertion of the needle ceases. (From White, James C. *Autonomic Nervous System*. P. 367. New York, 1935. MacMillan Company.)

does in many, but not all cases, reduce or abolish the trigeminal pain. If only one of the branches of the fifth nerve is involved, direct injection of novocaine into and around the affected nerve will afford relief for a varying period. In some few instances, complete and long continued relief has followed such injection. In a similar manner injection of alcohol (95 or 100 per cent) will bring relief for a longer period; in some cases the relief may be permanent. When alcohol is injected into the Gasserian Ganglion, the method of Hartel or of Schloesser is to be recommended. To render the application as easy as possible I have condensed the technic into the following rules:

1. The proper instruments must be at hand. They consist of:

- (a) Two cc. capacity, record syringe.
- (b) A 10 cm. long and 0.8 mm. wide steel cannula, heavily nicked, with a beveled point and a movable clasp.

The needle used by Patrick of Chicago is 12 cm. long and 1.75 mm. thick, a much thicker needle than is Hartel's. The advantage of this latter needle, according to Patrick, is that it is not so liable to break, and the direction of its point can be more easily changed by changing the direction of its base.

(c) A fine cannula for producing wheals in the preliminary skin anesthesia.

(d) A centimeter metal ruler.

## 2. Solution:

(a) For anesthesia, ampules of novocain are used. Braun recommended the addition of epinephrin.

Cocaine (75 per cent) was used by Offerhaus, but this was found to be too dangerous, so that now novocain which is much better and less dangerous is in general use.

(b) For neuralgia, 80 per cent alcohol for injection of the Gasserian ganglion is used. The solution used by Patrick in his first injections for trigeminal anesthesia consists of cocaine hydrochlorate, gr. 1, chloroform  $\text{m}$  X, alcohol  $\text{5 iii}$ , distilled water  $\text{5 ss}$ . Of this 2 cc. is injected. However, it has been found that all the ingredients except the alcohol are absolutely superfluous.

(c) *Position of the Patient.* The patient lies on a table, with the upper part of the body slightly elevated and a support under the head.

(d) The skin of the cheek over the area of injection is disinfected either with alcohol or with tincture of iodine (5 per cent).

(e) The skin at this point is rendered anesthetic by producing a small wheal by the injection of a few drops of 2 per cent solution of novocain.

(f) The long cannula is then taken and the movable clasp is placed at a distance of 5 to 6 cm. from the point. In cases of swelling of the cheek, etc., the distance is somewhat greater.

(g) *It is important that the needle be inserted in the proper direction.* This direction is such that if the needle is observed from in front, it must point directly to the pupil of the eye on the same side; while if it is observed from the side, it points directly to the articular tubercle of the zygoma. If on observation from in front the needle points too far inward, it will penetrate the eustachian tube and the solution will run into the pharynx.

If one does not observe these rules it is possible that the cannula may be carried too far forward and be inserted into the jugular

foramen. In one case, on the cadaver, Hartel found that the cannula had penetrated this canal and its point was seen in the dura at the

novocain) is slowly injected, drop by drop. If resistance to the injections should be too great, one does not attempt by increasing the pressure

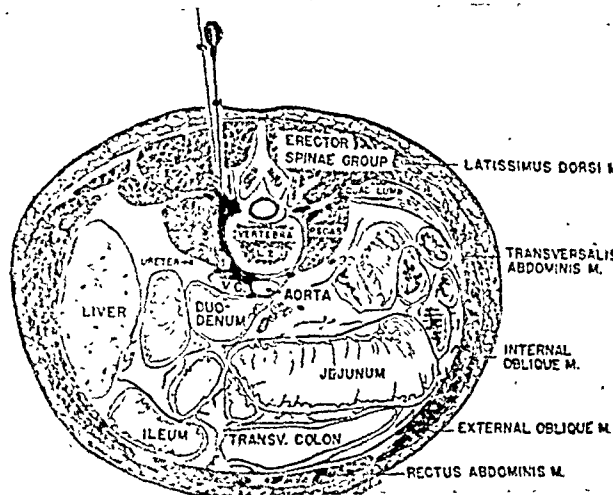


FIG. 10. Shows the method of insertion of the needle and its deflection, so that on further insertion the tip will come into contact with the sympathetic ganglion of the lumbar or thoracic ganglia. The sections of the rubber tubes as distance guides are indicated. (From White, James C. *Autonomic Nervous System*. P. 373, New York, 1935. MacMillan Company.)

place of entrance of the vagus and the glossopharyngeal nerves. The carotid foramen is very close to the foramen ovale, being on an average only 12.7 mm. distant, so that there is some danger in penetrating the carotid foramen. On the contrary, the jugular foramen is some distance away, being separated by an average distance of about 20 mm.

(h) The entrance into the foramen is indicated by the giving away of resistance and the presence of radiating pains in the area of distribution of the third branch. Patrick says that sometimes when the needle strikes the nerve, pain does not result, or at most, only a sensation of pins and needles is felt. When the needle has entered the foramen ovale the clasp is drawn back 1.5 cm. and the cannula is then pushed further into the foramen ovale until the pain is felt in the region supplied by the second branch, that is in the upper teeth, upper lips, gums, etc. In the last stage of the procedure no strong resistance should be felt, and if it is, the needle is in the wrong direction and must be removed and then reinserted in a different direction.

(i) After being certain that the needle is in the Gasserian ganglion the syringe is attached and  $\frac{1}{2}$  to 1 cc. of the solution ( $\frac{1}{2}$  per cent

to force in the solution, but rather draws out the needle to a slight degree and finds that then the solution runs in with but little resistance. If an alcohol injection is desired, we proceed under the same technic as the above, with the only exception that instead of  $\frac{1}{2}$  to  $1\frac{1}{2}$  cc. of 2 per cent novocain-suprarenal solution only a few drops are injected in order that the later procedures may be painless. Immediately following the onset of anesthesia the alcohol ( $\frac{1}{2}$  cc. of 80 per cent) is injected directly into the ganglion. If only a temporary anesthesia, such as is necessary for operations, is needed, the alcohol injection is not made. The latter is employed only when a permanent anesthesia is desired, for instance such as is indicated in the treatment of trifacial neuralgia when a permanent anesthesia is desired. The patient must keep the reclining posture for one hour.

If the injection treatment is unsuccessful, intracranial section of the sensory root of the ganglion is the only method of control which is available.

*Intercostal Neuralgia.* The best measure to control the pain of intercostal neuralgia is the injection of a few cc. of

2 per cent novocaine solution or if a permanent anesthesia is desired, an injection of alcohol (95 per cent) is made into the



FIG. 11. Shows how spread of anesthetizing solution surrounds the sympathetic ganglia. (From White, James C. *Autonomic Nervous System*. P. 369. New York, 1935. MacMillan Company.)

proper intercostal space, just anterior to the angle of the associated rib which should be defined with the point of the needle. By careful exploration the lower margin of the rib is found and, beneath it where the intercostal nerve is located, the alcohol should be injected. The technic generally used is that advocated by Labat:<sup>19</sup>

"The intercostal nerve is separated from the pleural cavity and lungs only by the thin internal intercostal fascia and is deeply situated beneath the longitudinal muscles of the back and the external intercostal muscle. The solution must be deposited between the external intercostal muscle and the internal intercostal fascia. The patient is placed on the side opposite to the one which is to be injected, the back arched, the face and knees are brought together so as to widen the intercostal spaces. A cushion is placed under the loin to straighten the vertebral column and obtain complete

muscular relaxation. Anesthetic wheals are raised at the points of greatest tenderness, 4 cm. distant from the midline. A needle [22 gauge, 8 cm. long] is inserted through the wheal and advanced in a direction perpendicular to the surface of the skin toward the posterior surface of the rib just above the intercostal space to be injected. After making contact with the rib the needle is slightly drawn back to change its direction; its hub is then inclined 45 degrees outward and upward and the needle reintroduced downward and inward toward the lower border of the rib, which is reached at different depths varying in different individuals and according to the height of the puncture in the same patient. The needle is finally advanced in the same direction 2 cm. further than the lower border of the rib. The direction of the needle is thus downward, inward and forward across the intercostal space, and its point buried between the intercostal muscles halfway between the two ribs and about 1 cm. in front of the transverse processes. The syringe is then connected with the needle and the injection made of 5 or 6 cc. of the 1 per cent novocaine solution. Half of the anesthetic fluid is injected without moving the needle, the rest is distributed in a fan shaped manner while the needle is being withdrawn. Care should be exercised when moving the needle to and fro (a) not to change its direction, (b) not to displace it more than 2 cm. and (c) not to approach the spine closer than when the injection was first started." (Figs. 1 and 2.)

When the nerve is contacted the patient usually complains of severe pain radiating around the same side of the chest. A few cc. of 2 per cent novocaine solution or 2 cc. of alcohol are now injected. If herpes is present it may be necessary to do a paravertebral injection. Radiation from the x-ray in proper dosage or irradiation by radium applied over the area of the pain may give relief and should be tried in all cases of persistent pain.

Sciatic neuralgia usually requires a paravertebral injection so that the upper cords of the lumbar plexus may be injected. Sciatica is very disabling. (Fig. 3.)

Pain due to neuralgia or neuritis of any nerve, may be corrected by direct perineur or in some cases intraneural injection of

novocaine or eucaine. If a more prolonged effect is sought the anesthetizing solution novocaine or eucaine or other agents should be dissolved in oil. Local applications of heat may be of value. Neuralgias or neuritis may prove intractable to any type of treatment except direct nerve desensitization or nerve section. (Fig. 4.) In all cases, however, attempts should be made to reduce the inflammation which may be present in the sheath of the nerve by removing the cause which in some cases may be the end result of circulating toxins.

*Paravertebral Injection.* Should ordinary measures for the relief of peripheral pain or for pains which radiate over the chest and abdomen fail, it is then necessary to attempt the control of these pains by a paravertebral injection of the affected nerves. Injections of the selected solution, as a rule, should be frequently repeated in order to obtain a more desirable result. If the pain continues to return after repeated injections a more lasting anesthetic and nerve destructive agent, such as alcohol, should be used.

Before attempting paravertebral anesthesia the operator should obtain a thorough knowledge of the anatomy of the region. The needle is inserted at a point 3 to 3½ cm. lateral to the midline of the spine on a line with the tip of the spinous process of the next highest vertebra. The insertion is continued until the point of the needle comes into contact with the transverse process of the adjacent vertebra; this is at a depth of about 3.5 cm. The tip of the needle is then slightly elevated and the insertion is continued to a further depth of 1 to 1.5 cm. with the point directed slightly outward. The entire needle is at an angle of 20 to 30 degrees to the surface. When pain or a sensation of tingling is felt in the areas in which pain had originally been present 5 cc. to 10 cc. of 2 per cent novocaine is injected. It is necessary to keep the point of the needle far enough removed from the intervertebral canal so that the solution cannot be forced along the nerve into the epidural space and it is also necessary to

avoid penetration by the needle and injection of the solution into any projection of the dural sac covering the lumbar or thoracic posterior spinal nerve roots. This method of injection is applicable to the thoracic region and the lumbar region. (Fig. 5.)

*Brachial Plexus Block.* Pain due to irritative changes or reactions in the brachial plexus will produce pain extending around the lower part of the neck, the back of the head and the upper part of the chest, the shoulder and into the arm, hand and fingers. Pressure by a cervical rib has been known to cause very severe neuralgic-like pains in the distribution area of the nerves arising from the brachial plexus. When pain is present in the distribution area of the nerves derived from the brachial plexus the plexus may be blocked with aqueous solution of novocaine (Tarsy and Steinbrocker<sup>21</sup>). It is highly effective in all intractable nonoperable disturbances of the shoulder region, also in fibrositis, myositis neuritis, bursitis and arthritis of the shoulder joint, the elbow and the wrist.

When the injection is given the patient lies on his back with his head turned away from the side to be injected and his hand is placed against the lateral surface of the thigh. The shoulder is depressed to bring the clavicle down, away from the chin as far as possible. An intradermal wheal is made at the midpoint of and slightly above the clavicle, and the novocaine solution is injected into the subcutaneous tissues in the line of the clavicle and about 3 cm. above it. The subclavian artery is now palpated and where it passes under the clavicle, at a point corresponding to the middle of the clavicle, a needle is introduced in a direction, which if prolonged, would meet the spinous process of the second thoracic vertebra. The needle is cautiously advanced until the tip comes into contact with some of the nerves forming the plexus.

Parasthesia (a sensation of tingling) or pain is felt in the area of distribution of the nerve with which the tip of the needle has



come into contact. The median is usually the first nerve with which the needle comes into contact and the radial usually is the next. In every instance as soon as tingling or a pain is felt, 10 cc. of a 2 per cent solution of novocaine is slowly injected. As the injection proceeds, the patient notices that the fingers and arm at first feel warm and then gradually become numb, and finally in ten or fifteen minutes complete anesthesia is present over the entire arm.

*Spinal Root Pain.* In some instances the pain may be due to a root lesion, i.e., inflammation, pressure by adjacent bone or exostoses, cord or meningeal tumor. According to Leriche<sup>22</sup> "a pain of root type has a characteristic topography. In some examples it may have no tangible cause, such as tabes, tumor, or Pott's disease. The neurologist has termed it radiculitis. A pain of much the same general characteristics but with a more indefinite distribution boundary may be due to changes in the thoracic or lumbar sympathetic ganglia or plexi. In such cases it may be necessary to infiltrate the dorsal or lumbar sympathetics. Usually the first injection makes the pain worse; after the second injection it disappears."

If the root pain is due to the irritation of the sensory conducting tracts in the spinal cord or if it is due to spinal meningeal lesion it can be permanently relieved only by proximal section of the spinothalamic tract in the spinal cord. If it is due to a tumor, a nucleus pulposus or a thickened subflavum ligament external to the cord the pain may be relieved by removing or correcting the lesion causing the pain. Tabes dorsalis also causes very severe and very annoying pain. It has the typical root distribution. Morphine, as a rule, only ineffectively controls it. To eliminate this pain it is necessary to stop conduction in the posterior roots. This may be done by section of the roots or by blocking of the conducting fibers, by intraspinal injection of alcohol according to the method of Dogliotti. This method requires hospitalization.

#### TREATMENT OF MUSCLE PAIN

*Tendency of Pain to Become Less Severe.* In our treatment of muscle pain, the so-called muscular rheumatism, it is well to remember that inflammatory pathologic reactions in the muscles frequently tend either to disappear entirely or to produce fibrous deposits or plastic exudate that becomes congealed and leads to the formation of connective tissue and adhesions. These adhesions, even though they are soft and of minimal strength, hinder motion between the fascial layers, movement between the fascial layers and the muscle bundles, and that of the muscle bundles to each other and to other anatomic structures, so that the sliding of one or all of these structures over each other is restricted and becomes painful. This condition is called myofascitis. Apparently the pain due to a myofascitis frequently is the result of chilling of the surface area of the body over the muscles which later become affected. Proper night covering should be provided and exposure of the sensitized area to drafts, cold air and chilling should be avoided. Toxic absorption from tonsils, teeth, gallbladder or intestine is a causative factor of importance and should be investigated and corrected. Toxic absorption leading to a chronic state of pain is also manifested in the neuralgic pains (neuritis—intercostal, sciatic). Chronic headache is another manifestation of the same type of pain.

In all cases in which intractable pain is due to inflammatory lesions absolute rest of the affected part must be instituted as long as the primary cause of the pain remains active. Persistence of the inflammatory process is indicated by increase in the severity of the pain on functional activity of the muscles. Chronic and noninflammatory states are improved on functional movement.

In résumé we may quote from W. J. Kerr:<sup>23</sup>

"Temporary symptomatic relief from pain may be obtained from drugs, salicylates,

phenacetine (10 gr.), and the barbiturates, aspirin in 5 to 15 gr. doses is also advisable. Cincophen 10 gr. twice daily may be of value, or *local heat* may be applied. This may be in the form of moist heat, radiant heat, electric pad, hot water bottles, the application of irritative plasters; or the use of a hot electric iron or flat iron moved back and forth along the spine over several thicknesses of a bath towel. Diathermia or the short wave current may also be used. Gentle massage and manipulation may be helpful. If the condition is chronic, the exercise and massage and forcible kneading undertaken should be vigorous. In some cases of cervical arthritis stretching of the neck may be resorted to with great relief. Violent manipulations can cause fractures of the vertebrae or their processes and should not be done."

If tenderness is not present on palpation of an area of the back or other part in which pain is complained of, the pain is likely to have been referred from some other region. This diagnosis is verified if there is in addition a skin hyperesthesia which is elicited by light pressure but can be abolished by deep pressure.

#### BACKACHE

The aching and distress of a painful back is one of the most disturbing ills. If severe, there is no position in which ease is obtained; day or night it may be master of the patient's thought, interfere with all business and social activities and have an influence on the functions vitally necessary for physical and mental well being. Pain decreased by sleep and rest in bed, felt most severely on arising in the morning and then decreased on movement of the body is a good diagnostic indication that the lesion is a myofascitis. In this condition there is a sort of fixation of the muscle; the individual fibers do not glide by each other with normal ease. Everything seems to be stiff and, using an appropriate term, somewhat frozen, so that there is retardation of the gliding mechanism of the muscles and other components of the area on each other.

Before attempting any physical corrective measures, the patient should be

stripped and carefully examined. The existence of a curvature of the spine, the presence of lordosis, kyphosis, scoliosis, etc., with the degree of vertebral fixation should be carefully noted. If the alignment of the vertebra is false, it should be corrected. It is surprising to find that a lift of one-fourth to three-fourths of an inch to the shoe of the foot, on the shortened side, will relieve many a pain due to a shortened limb. The posture assumed by the patient may be the cause of vertebral and muscular strain; if so, it should be corrected. Weak muscles are to be strengthened by appropriate exercises. If this is unsuccessful, a protective support is to be used.

If pain is also referred down the leg particularly in the sciatic area, especially if there is a history of injury which affected the back, we should eliminate the possibility of an injured intervertebral disc or a nucleus pulposus.

Indications for injections of analgesic producing substances into painful muscular or ligamentous areas are given, when, after thorough physical examination and study, visceral disease has been eliminated as the source of pain. Corrective injections may be used in traumatic, rheumatoid, or degenerative processes of joints, peri-articular tissues, nerves, bursae and muscles.<sup>24</sup> Before injections are made into the muscles of the back, referred pain from the viscera should be excluded. In some instances a *pendulous abdomen* will cause back pain by its excessive drag and distortion of the vertebral column. A proper fitting abdominal support and dietary correction of the overweight will frequently relieve the pain.

If intramuscular injection is necessary, it is made directly into the painful area. Aqueous solutions of an anesthetic agent cause evanescent effects which pass away in a day or two. A much longer period of relief follows the injection of an oily anesthetic solution.\* Injection of sarapin, a

\* Injections should be made with great caution in diabetic patients and under no circumstances should be made in patients with diabetes not under control.

substance found in the pitcher plant, may be used. Thiodocaine, a preparation introduced by the Midy Laboratories, Paris, also has been used. Quinocaine also has given good results. Before the pain returns to its previous severity the area should be again injected and this should be repeated for as many injections as may be necessary. In some instances it may require an injection every two or three days for several weeks; in other individuals one or two injections may give permanent relief. At the least return of the pain the injection should be repeated.

Before giving regional and local injections there should be a routine preliminary sedation with phenobarbital (1½ gr. tablet administered orally twenty to thirty minutes before treatment).

*Technic.* The site of maximum tenderness is determined by palpation or is best defined by the patient who presses in with his index finger, (scattered areas of marked tenderness may be present). These points which are the ones selected for injection are marked with a skin pencil. These sites should be sterilized with alcohol, tincture of iodine, tincture of methiolate or some other antiseptic.<sup>25</sup> Small intrasubcutaneous wheals are made in the marked areas by injecting a 2 per cent novocaine solution. A needle, 22 to 24 gauge and 10 cm. long is now inserted deep into the muscular tissues (generally to a distance of 3 to 5 cm.) and 5 to 20 cc. of aqueous solution, or 1 to 5 cc. of oil solution of the selected anesthetic agent is injected directly into the site of the pain and tenderness. If the needle encounters an extremely painful area, it is slightly withdrawn and the solution is slowly injected. If a fascial or muscular resistance

plane is encountered about 5 cc. of the aqueous solution is injected, or about 2 cc. of the solution in oil. The needle is then inserted deeper until the tip comes into contact with bone. It is then slightly withdrawn and more solution is injected. If the needle is not slightly withdrawn, the solution may be injected into or under the periosteum and severe pain may follow the separation of the periosteum from the bone. The minimum of force should always be used. During the injection, repeated attempts are made by drawing back the piston to aspirate blood or fluid, in order to determine if the point of the needle has penetrated a blood vessel or perhaps has entered the spinal subdural (arachnoid) space. If painful, sharply circumscribed, subcutaneous or intramuscular nodules are palpable, they are penetrated with the needle and a few cc. of the solution are injected into the center of each nodule; the treatment is completed with radiating injections of 3 to 5 cc. of the aqueous or oil solution about and beyond the nodule. If a nodule remains persistently and exquisitely tender, 0.5 cc. of 95 per cent alcohol is injected into the nodule and 5 cc. aqueous solution of novocaine about the site of pain.

The pain of extensive fibrotic involvement of fascia or muscles, particularly in the gluteal and low back regions, can be relieved by injections of 10 cc. of 2 per cent procaine followed by 25 to 100 cc. of normal saline. After injection is completed the needle is quickly withdrawn and slight pressure is made over the site of the injection. Tenderness and crepitation frequently disappear after one or two such treatments.<sup>26</sup>

If the anesthetizing fluid is injected too superficially, bulging of the injected area will follow and may needlessly alarm the patient. Previous warning that such a swelling may occur and be painful should be given to the patient. It is also common for pain to persist several hours after the injection. These pains, according to Steinbrocker<sup>26</sup> are usually due to excessive

They also should not be made in areas adjacent to infections, in severely debilitated individuals, in those who are critically ill or in those sensitive to the anesthetizing drug. Injection treatment should not be used when acute inflammatory reactions are present, or if surgical measures are preferable. In patients who are at high risk this method of treatment should not be used, as it has been known to produce shock resulting in death.

trauma in the passage and manipulation of the needle, or may be due to backflow of the medication, infiltrating and irritating the superficial tissues. The after-pains are relieved by heat applied locally with an electric pad, hot water bottle or warm baths followed by gentle massage.

To facilitate the separation of muscle bundles and fascial planes, forcible massage, percussion of the affected area and vibratory massage should be given immediately after the injection. Direct application of heat by hot packs, hot baths, or by diathermia short wave, infra red ray or the incandescent lamp should also follow.

In our treatment of myofascitis we should not be deceived in regard to the origin of the crepitation which is both heard and is felt on movement of the affected part, especially if the cracking sound and sensation is near a joint. This crepitation is seldom caused by disturbance in the articulation, such as would be produced by the rubbing between two opposing eroded joint surfaces, but is the result of friction from the over-riding rough surfaces of muscle, ligaments and tendons. If the condition is acute, one or two injections of an anesthetizing solution directly into the crepitating areas may suffice to relieve both pain and crepitation. If the condition is chronic, repeated and long continued treatment may finally lead to success. As Maliwa states, "we should not be discouraged by the necessity for prolonged duration of the treatment which for a long time may be without effect."<sup>27</sup>

After the injection the muscles should be put to use, and active exercise and calisthenic movements should be undertaken. Abnormal postures and positions should be avoided. Occupational habits leading to muscle strain or to overexertion should be corrected. Improvement in the well-being of the patient will follow rest and sleep. For this reason, temporary use of narcotics may be necessary; on the relief of pain the patient's outlook is brightened, his morale is stimulated and the use of pain controlling drugs is eliminated. The patient is happy

and cooperative for the intramuscular injection may give the first appreciable relief that has been obtained in an extended period of discomfort and disability.

The beneficial effect of analgesic solutions injected into a painful area probably is due in part to direct separation of the components of the affected tissues from each other by the volume of the injected solution; and indirectly by increased nutrition of these tissues and the improved local elimination of toxic and deleterious substances due to the hyperemia, which results from the vasodilation arising from the blocking of the sympathetic nerve supply to the blood vessels by the anesthetizing agent. It is also probable that a form of regional shock therapy occurs. This adds a further congestive factor to the hyperemia. Large quantities of fluid injected into the muscle and fascial tissues also facilitate the desired effect. The presence of free fluid facilitates the movement of the muscle tissue bundles and fascial layers on each other, especially so if the adjacent approximating surfaces have become roughened or dessicated. Drying out and roughening of the tissues may be presupposed from the crepitation which is present on movement. On the injection of novocaine, eucaine or other substances dissolved in water or in oil, the crepitation ceases but again may be felt and heard when the fluid is absorbed.

It is also to be inferred that solutions (anesthetic in character) injected into the muscle and the fascia will separate adhering muscle bundles and fascial layers, and render insensitive the fine terminals of the sensory nerves which are irritated by the abnormal pathologic factors which are present. For the maximum effect, complete infiltration of the involved tissues should be sought.

#### ARTHRALGIAS

In our review of intractable persistent peripheral pain we must consider the arthralgias (joint pains). At times articular pain may be so severe and persistent that

life becomes almost unendurable. Examination of the affected joint may not reveal any lesion of sufficient magnitude to be rated as the cause of such disturbing pain. In some instances rheumatoid or degenerative lesions may be present in or around the joint, or the joint ligaments, peri-articular fascia or bursa may be involved; but these usually are found to be old lesions and can hardly be associated with pain of recent origin of which the patient complains. In many instances the joint pain follows trauma such as a slight twist, or strain upon the joint.

In some cases crepitation or grating may have been present in the joint for a long time, but was not associated with pain, until some unusual movement or exposure to cold and dampness apparently was followed by further joint disturbance and pain.

In some instances no manifest lesion can be demonstrated and the certainty of the presence of such an anatomic lesion may be questioned. The actuality of the pain, however, cannot be doubted if the usual expressions and reactions indicating pain are to be considered reliable. After peri-articular injections, the pain ceases and may not return, although the lesion originating the pain must still be present; for it is fantastic to suppose that peri-articular injections can immediately correct the pathology originating the pain.

*Peri-articular Injection of Articulations, Especially the Sacroiliac, Shoulder, Hip and Knee.* These articulations are often the site of severe pain. The discomfort arises from irritation of the nerve fibers supplying strained, ruptured or infiltrated peri-articular tissues, tendons and ligaments. These tissues are particularly involved at their insertions and attachments. All tender areas should be injected and the solution should be spread out in a fan-shaped manner around the joint. If the solution enters the joint it may cause some pain and temporary swelling of the joint. This disappears in a few days. Direct injections of

the joint may be made if the pain is due to irritation in the joint.

*Sacroiliac Injection.* At times the pain in the back is low down in the lumbar area and involves the sacroiliac area. In such cases the patient when requested to indicate the painful and tender areas, will frequently place his hand over the upper sacral region and the lateral iliac crest. Pressure over the sacroiliac joint usually is painful.

#### NONOPERATIVE PROCEDURES FOR THE RELIEF OF LUMBOSCIATICA

W. M. Steel<sup>28</sup> states, "The pain of chronic lumbosciatica is transmitted down the leg through the lumbosacral and coccygeal plexuses, particularly along the great sciatic and gluteal nerve distributions. The pain is intermittent; it is aggravated by sudden body twists, lifting, exposure to wet and cold or toxic focus. The majority of cases are in this class and are apt to be relieved by minor surgical procedures."

##### *Plan of Treatment*

1. Eliminate possible etiologic factors
  - (a) Toxic foci or sources of referred pain
  - (b) Correct faulty posture
  - (c) Correct flat feet
2. Measures to absorb local fibrosis and free adhesions
  - (a) Heat and massage
  - (b) Passive motions
  - (c) Nerve stretching
    - (1) Postural and open methods
    - (2) Endoneural sciatic injection
    - (3) Epidural intrasacral injection

According to Steel, if the above measures are unsuccessful or too tedious, pain relieving injections of appropriate solutions may be used. Injection should be made into the painful areas and should be extended down to the underlying bone. At least 20 cc. of the anesthetizing solution should be injected over each sacroiliac articulation. Afterward, forcible rotation and extension of the pelvis is to be carried

out. If the pain radiates down the outer side of the leg and there is an associated involvement of the iliotibial band and the piriformis and adductor muscles, the solution should be injected into the tender spots over the involved areas and should be diffused in a fan-shaped direction through the involved muscular areas. Twenty cc. or more of a 2 per cent solution, 5 cc. of procaine or novocaine in oil or 10 cc. of thiodocaine solution can be used. The injection should be followed by active and forcible massage, even pummeling of the muscle may be effective. Forcible but not abrupt and jerky hyperextension of the back, flexion, adduction and abduction of the thigh should conclude the treatment. After-treatment should be rest with the application of heat, diathermia or the short wave. (Fig. 6.)

The same procedures should be repeated every few days until the pain ceases permanently. In the intervals between injections, heat applications, exercise, and massage should be continued.

#### SHOULDER PAIN

It is not unusual for the practitioner of medicine to be confronted by a patient who complains of severe pain in the shoulder, radiating down the arm, with areas of pain running transversely across the lower third of the upper arm, in the elbow region and on the dorsum of the hand. These areas, especially those in the upper arm, are painful to pressure. Pressure on an area below and external to the acromion process is also painful and may cause pain to radiate down the upper arm. A peculiarity of these pains is that it is very difficult for the patient to locate them exactly in any one particular and definitely delimited area. The patient also is unable to raise his hand above his head, he cannot comb his hair with the affected hand nor, if he is a man, can he put his hand into the hip pocket on the affected side.

If the above pain references are due to involvement of nerves, it seems remarkable that all pain in the shoulder and arm may

be relieved by injection with novocaine or other desensitizing solutions into the area where localized tenderness is most marked which in many instances is inferior and lateral to the acromion process.

The explanation of the bizarre and unconventional relationship of the pain areas to each other is that there must be some indirect reference of causative stimuli, probably through the medium of sympathetic nerve distribution. It is also remarkable that forcible manipulation, by which the myofascial adhesions are broken, will in many instances give immediate relief of pain to such a degree that the patient can raise his hand above his head without pain. Previously he could not raise the affected arm higher than at a right angle with the body.

It is true that the pain may return but additional injections can be given and repeated manipulation may be used. After correction, massage of the shoulder and arm must be given and heat, moist or dry, must be consistently applied. The arm should be used. It must be protected from chill and drafts.

If the pain in the lower part of the arm or in the forearm is not relieved by the higher arm injections, other injections should be made into the painful areas in the lower arm and in the forearm. If a contracting muscle band or painful nodule is located, the anesthetizing solution is injected directly into the nodule or into the contracted muscle bundle and at its fascial insertions into the bone.

A significant indication of noninvolvement of the joint is that after the muscle injections free movement of the bones forming the joint is possible without the production of pain.

#### HIP PAIN

When a man or woman comes limping into the doctor's office, he or she will frequently claim that the limping is due to pain which they have in the hip. They may give no definite causative history

except that at one time they had a mis-step and the pain followed. It may have been present for months. Drugs and various applications to the skin have relieved it but it always returns and is then as bad if not worse than it was previously. Examination shows perhaps some atrophy of the leg muscles on the affected side but not more than would result from lack of use. Attempts to elevate the leg to a straight position perpendicular to the table, when the patient is lying flat on his back, causes great pain referred down the leg. Yet, there is no very severe pain when pressure is made over the course of the sciatic nerve. In these patients tenderness is marked in an area posterior to the head of the femur at the point of insertion of the fascia of the tensor vagina femoris. In this area, 20 cc. of anesthetizing solution is injected.

It is frequently a necessity that the narcotizing solution be injected into the area of the sciatic nerve deep in the buttocks. (Fig. 7.)

Injection should also be given into any of the nine points where it will be most effective. In every instance, injection should be made into the painful areas of the muscles where they are attached to the bone. Injection into the upper cord of the lumbosacral plexus should be made through the triangular space between the crest of the ilium and the lower lumbar vertebra. Injection should also be made in the tender areas over the sacroiliac articulation. In each of these areas, 5 to 10 cc. or more of the anesthetizing solution should be injected. If the areas are very numerous, they should be injected in two or more sittings.

*Knee.* The seven point injection scheme of Forestier<sup>29</sup> for the knee will require two or three sessions. If aqueous novocaine solution should enter the joint a slight reaction will usually follow. If the oily solution was used, a mild, acute, chemical arthritis with swelling of the joint and pain may ensue. The effusion into the joint appears in six to twelve hours and lasts for a few days. (Fig. 8.)

*Foot.* Flat feet cause pain which is referred to the inner side of the knee, to the calf muscles, and along the insertion of the articular ligaments. Injections should be made into the painful areas of the foot in flat foot, broken transverse arch, in the areas of pain in hallux valgus (bunions), in exostoses (spurs) and in Morton's metatarsalgia. Of course in these conditions it is necessary to correct the gross anatomic defects and abnormalities. The injection of analgesic solutions is of great value when quick relief is urgent. That proper orthopedic measures be used in association with corrective measures for relief of pain is indicated in the case of a patient who after removal of spurs on the os calcis had pain in the operated area on standing. This was relieved by building up and fitting a proper support for the arch of the foot.

#### SYMPATHETIC NERVOUS SYSTEM

*Pain Due to Involvement of the Sympathetic Nervous System.* In patients in whom efforts to relieve the pain by treatment directed at the somatic nervous system are unavailing, attention should be directed to the sympathetic nervous system. The proportionate involvement or activity of the somatic and of the sympathetic nervous system should, if possible, be determined. It is only recently that the medical profession has been cognizant of the great part played by the sympathetic nervous system in the induction and the continued manifestation of pain. It is seldom recognized that many of the severe pains following an injury of, or involvement of the somatic nerves of the periphery are of sympathetic origin. These pains are extremely difficult to control, and are not amenable to treatment except by desensitization of the appropriate sympathetic ganglia (by localized injection of narcotizing drugs) or by sectioning or resection of the sympathetic cords. Late in the disease no type of curative procedure may prove effective; for this reason, corrective measures should be instituted early in the condition.

Characteristic of these pains is the indefiniteness of their localization, the variability of their intensity and the inconstancy of their manifestation; at times they are persistent and again they come and go. At all times the patient is miserable and depressed. This is consonant with the fact that the pain, which has its origin in the *sympathetic nervous system*, seems to affect the general well-being of the individual more than do pains of somatic origin. A reason for this may be that the sympathetic nervous system is closely connected with the vital processes and functions of the body and is a co-regulator of the visceral activities, so that disturbance in one of its divisions may involve the other divisions and have a far reaching effect.

It is also true that pain of sympathetic origin is of particular importance because many of the viscera give rise to pain sensation transmitted through the sympathetic nerve fibers; the most important of these are the pains referred from the kidney, liver, uterus and adnexa, heart and lungs. Since there is no pain sensation located directly in the viscera, abnormal impressions are reflected into peripheral somatic distribution areas where they are felt as pain.

Relief of the pain reflected from the internal viscera may be obtained by injection of the appropriate sympathetic ganglion or ganglia with narcotizing substances or with alcohol. The pain of angina pectoris may be relieved by injection of desensitizing substances or of alcohol in the upper four thoracic ganglia on the left side, pain derived from the kidney by injection of the lumbar ganglia; genital pain can also be controlled by injection of the lumbosacral sympathetic plexi.

In studying the relation of pains of somatic and of sympathetic origin, R. Leriche<sup>22</sup> noted a remarkable integration between the somatic and the sympathetic nervous system. He found that, "If in the case of a pain with a well defined topography—a pain of unchanging character, and which has no definite irradiations, a

pain, that is to say, of the cerebro-spinal type—the corresponding sympathetic ganglion is infiltrated, the pain disappears. The anesthetizing of the one system abolishes the pain which affects the other."

If we consider the extent and volume of the sympathetic nervous system it is easy to understand how extensive and severe disturbances may follow any maladjustments of its functions or insults to its integrity. It is reasonable to suppose that changes in its structural components, or environmental relationships may occur and give rise to severe disturbances, some of which are manifested by pain. As the activities and influences of this system are becoming more clearly defined we are increasingly amazed at the imputations which they present.

Many of the adverse complaints due to involvement of the sympathetic nervous system may be corrected by desensitization, or destruction of the sympathetic transmission pathways by injection of narcotizing solutions into and around the ganglia and sympathetic plexi. This procedure is not as complex nor as difficult as it seems, because the sympathetic plexi and cords lie anterior and lateral to the bodies of the vertebra and can be reached comparatively easy by a properly introduced needle through which the narcotizing substance is injected and infiltrates the adjacent tissues.

*Technic of Injection: Cervical and Upper Thoracic Sympathetic Ganglia Injection.* Have patient lie on the side opposite to that which is to be injected. The shoulders are at the edge of the table, the spine is flexed and the knees are drawn up; the head is supported on pillows so that the spine is straight. Hands are uncovered so that they can be observed and the effect of injection noted. If alcohol is to be injected, it is preferable to do the injection in the patient's bed. Complete immobility for one hour is stressed so that the alcohol does not become diffused by movement after the injection, with involvement of adjacent nerves and tissues. (Fig. 9.)



*Technic.* The prominence of the dorsal spine of the seventh cervical vertebra marks the level of the transverse process and the angle of the first rib, and this relationship holds true for each succeeding spinous process. The point of insertion of the needle is indicated by a mark 3 to 4 cm. from the middle of the back on a line, level with the spinous process of the selected vertebra. This mark is made by tincture of iodine followed by acriflavine; both are applied by fine cotton applicators.<sup>30</sup> A fine gauge (22) needle, 8 to 10 cm. long is inserted at the point indicated, perpendicular to the skin, to a depth of about 3 to 5 cm., until it comes into contact with bony resistance (the transverse process of the vertebra or the rib). The depth marker, a small piece of Dakin's tubing which is impaled on the needle, is now adjusted to a distance of 3 cm. from the skin. The needle is inclined slightly in a caudal direction and after the edge of the lower border of the rib is located, it is inserted to a further depth of about 3 cm. at an angle of 20 degrees to the midline. Usually at this depth the resistance of the lateral aspect of the body of the vertebra is felt. It is gradually edged along this resistance until a depth of 3 cm. is reached. The needle is now attached to the syringe. Two to 3 cc. of a 2 per cent novocaine-adrenalin solution or a similar amount of thiodocaine or alcohol is injected. The solution bathes the sympathetic trunk, the sympathetic plexus, and the spinal nerves which lie in the lateral vertebral groove. If characteristic signs of anesthesia do not follow in a few minutes, 3 cc. of a 1 per cent solution is injected in the same areas.

If the tip of the needle should enter an intervertebral prolongation of the dural sac (cerebrospinal fluid exudes from the needle), or should it penetrate the pleural cavity (cough occurs) or if it enters a blood vessel (blood would drop from the needle). Aspiration should be attempted in every instance before the solution is injected.

When the upper four thoracic ganglia are injected and the nerve blocking is

effective, skin anesthesia develops in the inner side of the arm, the axilla and the area of the third and fourth ribs, the hand, the arm and the same side of the head and face become hot and dry. A Horner's syndrome is manifested. (Fig. 10.)

If permanence of anesthesia is sought 5 cc. of 95 per cent alcohol is injected after the primary 2 cc. of 2 per cent novocaine-adrenalin has been injected into each lateral vertebral sulcus.

If severe pain occurs at any stage, the injection is stopped for a few minutes until the patient recovers his equanimity. The patient is kept quiet for at least an hour after the injection.

The anesthesia of the skin to visceral referred pain is permanent but the skin anesthesia of painful areas due to involvement of the intercostal nerves is not permanent.

*Lumbar Sympathetic Ganglia Injection.* The patient lies on the abdomen. The dorsal spines are identified, the spine of the fourth lumbar vertebra is at the level of a line drawn between the crest of the two ilia. The transverse processes of each vertebra lie directly lateral to each spinous process.

*Technic.* A needle (22 gauge) 8 to 10 cm. long is inserted 3 cm. lateral to the upper margin of the spinous process of the appropriate vertebra. It is pushed perpendicular to skin to a depth of 4 to 5 cm. when it usually encounters the transverse process. When it does so, the rubber marker is drawn back 3 cm. The point of the needle is now moved upward or downward until it passes the obstructing transverse process. The needle is deflected to an angle of about 20 degrees with the midline and inserted until the lateral body of the vertebra is encountered. Gradually, the point of the needle is cautiously advanced along the vertebra until the progress is unopposed. Should parasthesia occur at any stage of this procedure, then it indicates that the lumbar nerves have been contacted and the direction of the needle is then slightly changed. The tip of the

needle is now in the space in which the sympathetic nerve trunks are found. If no fluid (blood or cerebrospinal fluid) drips from the needle, the syringe is attached and 2 cc. of 2 per cent novocaine is injected. (Fig. 11.)

If the injection is successful, there is immediate warming and drying of the corresponding foot, anesthesia of the skin of the back, the side of the buttocks and the peripheral distribution skin areas of the genitocrural, the anterior femoral and the lateral femoral cutaneous nerves.

When the above occurs, more 1 per cent novocaine-adrenalin solution or 3 to 5 cc. of 95 per cent alcohol may be injected if a permanent paralysis is contemplated.

Injections may also be made at the levels of the second, third and fourth lumbar vertebrae. The position of the fifth lumbar vertebra precludes injection lateral to its body.

Paravertebral lumbar injection is indicated in painful lower extremities when the pain is due to vasomotor neuroses. Caution should be exercised in ischemic painful conditions as in pain caused by diabetic gangrene in which the pain may be due to vasomotor spasm or organic occlusion, also in endarteritis, Raynauds intermittent claudication, and atypical neuralgias in which no definite nerve distribution area is involved. The so-called causalgias may be relieved by paravertebral injections. Referred visceral pain may also be relieved in many instances by paravertebral sympathetic nerve injection.

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# MANAGEMENT OF LOCAL ANESTHESIA, PARTICULARLY FOR THE DIABETIC PATIENT\*

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**D**IABETIC patients are subject to the same conditions which effect those without diabetes and are particularly prone to infection and acidosis. They are also quite liable to arteriosclerosis with its attendant cardiac and renal damage. Infection renders diabetes more severe and intractable, and therefore requires more radical treatment than is necessary for most other patients. General anesthesia has a tendency to produce or increase acidosis. If real anesthesia can be obtained by means which will not disturb the diabetic patient's delicate metabolism, a great advantage is obtained. Thus, for major surgery of the abdomen, pelvis and lower extremities, or for perineal surgery, spinal anesthesia is usually easy and safe if one understands its limitations. If such procedures are imperative on diabetic patients with marked cardiovascular disease, field block and splanchnic nerve block are preferable for the abdomen and a combination of caudal and sacral block for the perineum.

Local anesthesia is a great boon to both the patient and physician in minimizing necessary procedures from the patient's point of view, and by increasing the comfort and thereby confidence with which patients submit to such procedures. The use of a local anesthesia is avoided by most physicians because of the time required and the frequent failure to produce good anesthesia. Failures occur because physicians overlook certain requirements such as the necessity for getting sufficient solution in the right places and allowing time enough for adequate anesthesia to ensue. These items are not difficult but allow of little compromise. However, they cause many men to dodge the issue of an accurate

knowledge of the nerve pattern of the area and the allowance of sufficient time from a busy practice. Actually very little time is required after one is accustomed to the use of local anesthesia, and if these procedures are done in the office, injections can be made and some other duty performed while anesthesia is occurring, so that when one returns to the patient in question, everything is ready to start and little time is wasted.

In general, the advantages of local anesthesia are: (1) less danger than almost any form of general anesthesia; (2) less reaction to, and quicker recovery from the necessary manipulation; (3) it minimizes the procedure; (4) in large operations there is definitely less shock per unit of time and trauma, and (5) specifically, there is much less disturbance of a diabetic patient's equilibrium and chemical balance. The instruments required are simple, and the accompanying photograph (Fig. 1) reveals a good layout for such practice.

It is best in all patients, and particularly important in those with diabetes, to obtain anesthesia with the least trauma, without over distention of tissue or the use of excessive fixative in the solution, either of which may produce avascularity with its attendant ills. It is important to avoid injection in the proximity of infection, and it is preferable to use field block at an adequate distance from this area. These objects are accomplished best with the 1 per cent solution of novocain containing 1 m. of pituitrin to each ounce, or 1 cc. to each 500 cc. of solution. Pituitrin is preferable to adrenalin because of its lessened constricting effect upon the coronary arteries which becomes very important in older patients or those with cardiac disease. Novocain solution

\* From the Department of Surgery, Temple University School of Medicine.

without some form of fixative to prevent its rapid absorption produces a very brief anesthesia often amounting to fifteen or

itself is painful and (3) to use adequate amounts for the areas to be blocked. Consideration of all of these factors is necessary

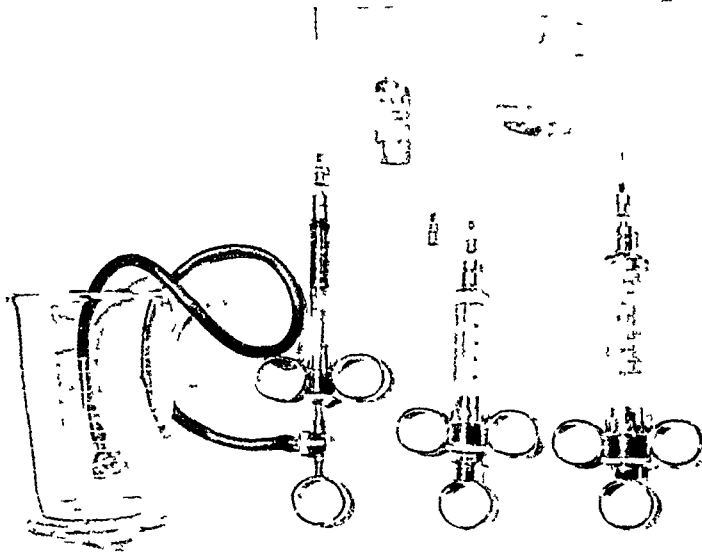


FIG. 1. Three and 10 cc. Luer-Lok ring-handled syringes and 3 cc. pump syringe and infiltrations with containers of various sizes for solution.

twenty minutes. Occasionally, this is adequate time, but if one waits ten minutes to allow the anesthesia to occur, there are many procedures which cannot be completed in the remaining five or ten minutes. In addition, a more prolonged effect decreases postoperative pain. The rapid absorption of novocain solution without some fixative or vasoconstrictor is much more likely to produce toxic manifestations. Conversely, large quantities, 500 to 600 cc., with fixative included, have frequently been used with only occasional mild toxic response and this usually was due to intravascular injection. Vessels should be carefully avoided. Aspiration with each new position of the needle will indicate the entrance of the point into a vessel by the withdrawal of blood into the syringe.

It is wise (1) to make a slow, gentle approach using very fine needles, at least for the original injection, and progress from anesthetized areas by subcutaneous advance of the needle to produce additional wheals from beneath the skin by means of which painless administration can be made; (2) to inject slowly, since rapid injection of

for an almost painless production of anesthesia which patients greatly appreciate.

#### REGIONAL BLOCK

It is important to consider the nerve pattern of special regions where minor surgery is frequently indicated.

*Toes.* Ingrown toenails, infections and the removal of warts or corns can be done painlessly by the injection of a collar of novocain at the base of the toe to interrupt the two plantar and two dorsal digital nerves which lie in the subcutaneous fat. This can be done with 5 to 10 cc. of solution and a 25 20 27 gauge one inch needle using one original and two subsidiary wheals to completely surround the base. (Fig. 2.)

*Foot.* If infection of the toe is fairly extensive, and particularly if it extends up on the dorsum, the use of ankle block is preferable to injection in the area proximal to the infection. This location of nerve interruption can be used for repair of lacerations or tendons, toe amputations, removal of ganglia, drainage of osteomyelitis, etc. Figures 2 and 3 will reveal that an injection immediately behind the

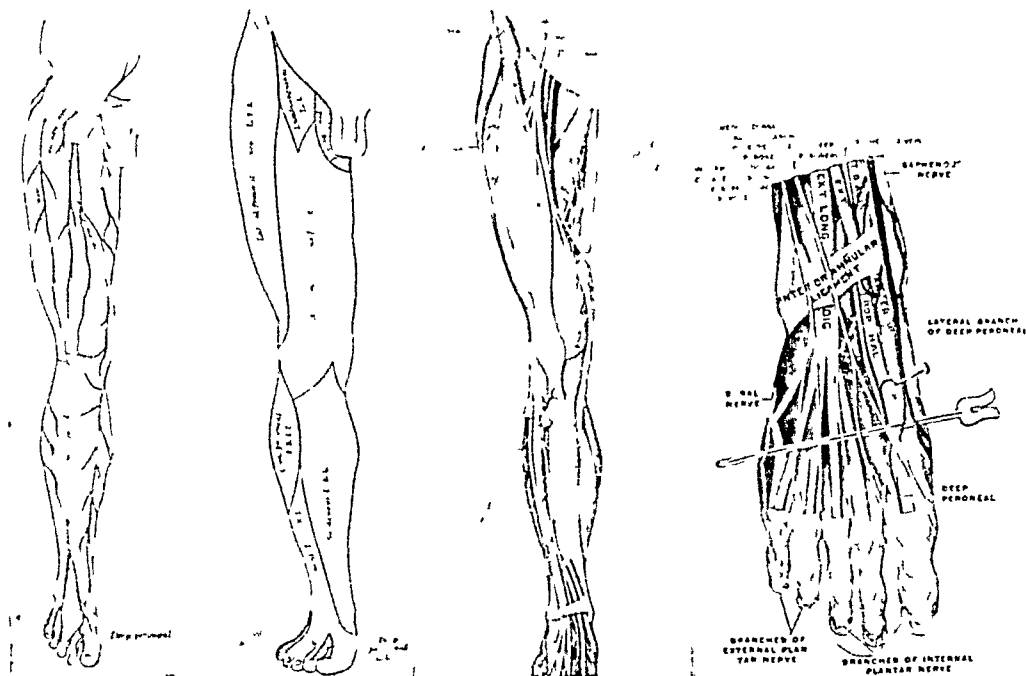


FIG. 2 Superficial and deep innervation of anterior surface of leg and foot. (From Gray's Anatomy, 23d Ed. Edited by Warren Lewis Philadelphia, 1936. Lea & Febiger.)



FIG. 3 Superficial and deep innervation of posterior surface of leg and foot. (From Gray's Anatomy, 23d Ed. Edited by Warren Lewis Philadelphia, 1936 Lea & Febiger.)

internal malleolus and just medial to the dorsalis pedis artery at the cruciate ligament will block the posterior tibial and the

higher up, (Figs. 2 and 3) will produce anesthesia of the foot and calf. Fifty to 100 cc. of solution are adequate.

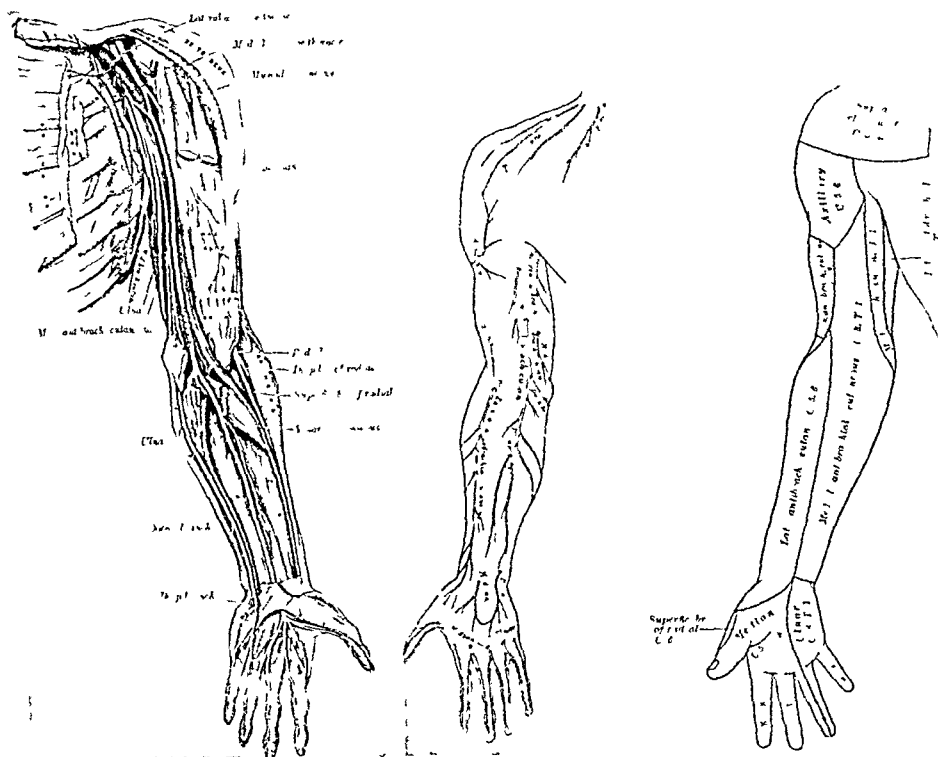


FIG. 4. Superficial and deep innervation of anterior surface of arm and hand. (From Gray's Anatomy, 23d Ed. Edited by Warren Lewis. Philadelphia, 1936. Lea & Febiger.)

deep peroneal nerves, respectively. These combined with a collar injection to interrupt the branches of the superficial peroneal on the anterolateral surface and of the saphenous in relation to the saphenous vein, will produce good anesthesia of the entire anterior half of the foot. Approximately 25 to 35 cc. of novocain will suffice.

**Calf.** If it is necessary to have anesthesia higher than this, as for amputation at ankle or midcalf, varicose vein ligation, etc., injection of the common peroneal as it passes around the neck of the fibula, of the saphenous as it passes from posterior to anterior on the medial side of the knee just below the head of the tibia, and of the posterior tibial in the popliteal space between the heads of the gastrocnemius and superficial to the popliteal artery where it crosses from lateral to medial, combined with a superficial collar injection to interrupt branches which have been given off

**Thigh.** Operation on the thigh, including even midthigh amputation can be done by injection of the sciatic nerve as it passes midway between the tuberosity of the ischium and greater trochanter of the femur, injection of the femoral nerve where it passes under the inguinal ligament just lateral to the palpable femoral artery, and of a circular barrier, both superficial and deep, of the thigh a few centimeters below these points to interrupt branches of the obturator, lateral femoral cutaneous and posterior femoral cutaneous nerves. This requires 100 to 150 cc. of novocain.

**Fingers.** Similarly, one can operate upon or manipulate the fingers by a basal block of a superficial collar similar to that advised for the toe. (Fig. 4.) Lesions likely to require minor surgery are: bone felons, paronychia, ganglia, lacerations, etc.

**Wrist.** For more extensive infections such as tenosynovitis, midpalmar and

thenar space collections, tendon suture, finger amputation, etc., good anesthesia of the entire hand can be obtained by a wrist

block superficial branches originating proximally. From 50 to 100 cc. of solution are required. Thus, closed or open reduction

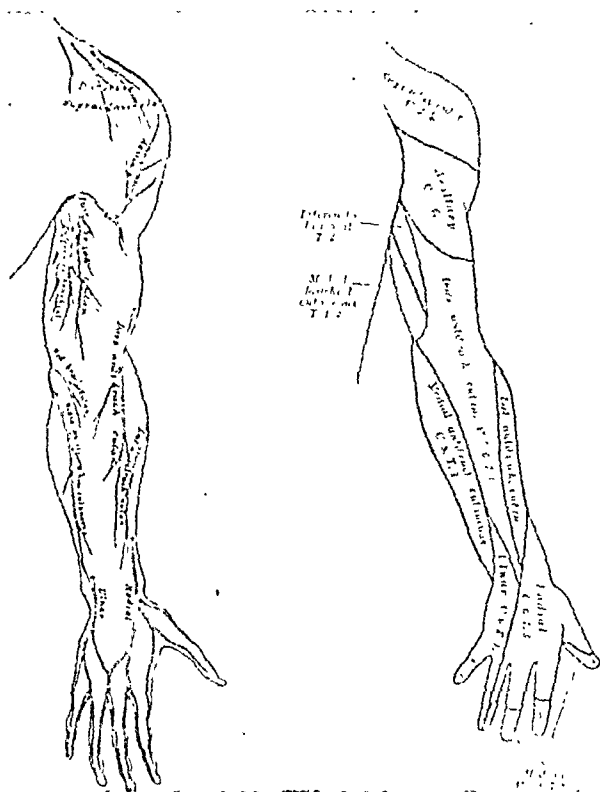


FIG. 5. Superficial innervation of posterior surface of arm and hand. (From Gray's Anatomy, 23d Ed. Edited by Warren Lewis. Philadelphia, 1936. Lea & Febiger.)

block using 30 to 60 cc. of novocain. Injections are made of the radial nerve just lateral to the radial artery, the median just to the ulnar side of the palmaris longus tendon between it and the flexor carpi radialis, and of the ulnar just medial to the associated artery. (Figs. 4 and 5.) This is finished off by superficial collar injection to interrupt branches given off above the point of injection of the nerve trunks. Forty to 60 cc. are sufficient.

**Forearm.** Operation on the forearm and hand can be conducted under elbow block (Figs. 4 and 5) interrupting the ulnar nerve as it passes posterior to the medial epicondyle, the median as it passes to the medial side of the brachial artery and the biceps tendon, and the radial as it emerges under the lateral side of the biceps tendon with again a superficial collar injection to

of fractures, drainage of extensive tendon infections which have progressed into the radial or ulnar bursa, nerve or tendon suture, tumors, amputation, etc., can be handled.

**Brachial Plexus.** This block is practically the most unsatisfactory of all the regional group and has been generally discarded because of its difficulty of induction. However, operations of a superficial character can be done under local infiltration of the area provided infection is not present.

**Cervical Plexus.** Figure 6 shows the ease with which the superficial branches of the cervical plexus can be blocked by injection along the posterior border of the sternocleidomastoid muscle half way between the mastoid process and the sternoclavicular junction. This is adequate for operations

on the skin or in the subcutaneous fat, and for the biopsy or removal of superficial lymph-nodes. For deeper anesthesia one

*Scalp.* For the scalp the simple rule of placing a horizontal barrier across an area roughly six times as long as the desired

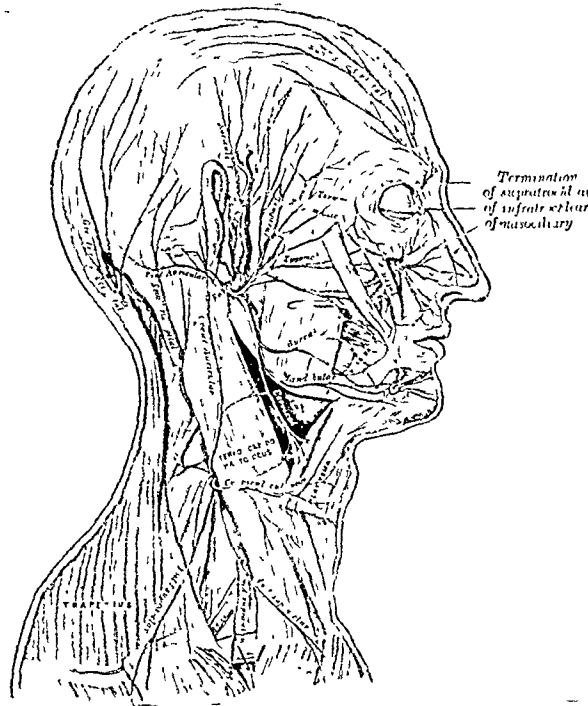


FIG. 6. Superficial branches of cervical plexus and of innervation of scalp and face. (From Gray's Anatomy, 23d Ed. Edited by Warren Lewis. Philadelphia, 1936. Lea & Febiger.)

has to palpate the transverse process of the second, third and fourth cervical vertebrae—the first is almost a finger's breadth caudal to the tip of the mastoid—and pass the needle medially under each of these, instilling a generous amount of anesthetic solution. If the manipulation is to occur near the mandible, a barrier is required in the superior part of the submaxillary space along the lower border of the mandible to interrupt the cervical and mandibular branches of the facial, mylohyoid and hypoglossal nerves. Since these are so difficult of exact location, it is best to place a barrier plane at the level of the inferior border of the mandible extending 2 or 3 cm. deep in a horizontal plane. Deep lymph-nodes, branchial or thyroglossal sinuses, thyroids, esophageal diverticulae, etc., can be corrected using such a block on one or both sides. Usually 50 to 150 cc. of solution are necessary for each side.

incision or other manipulation and caudal to this area will produce satisfactory anesthesia, since all the nerves extend fairly straight upward and are therefore interrupted by such injection. Thus lacerations, sebaceous cysts and angiomas can be treated, and even craniotomies can be done.

*Face.* Injection of the face is one of the most difficult feats in local anesthesia and usually multiple injections are required. However, the supraorbital, infraorbital and submental foramina are palpable and the branches of the nerves can be interrupted as they emerge from these foramina. For extensive work on the face, however, it is necessary to block the semilunar ganglion of the fifth and of the facial as it passes forward anterior to the mastoid process and deep under the parotid gland. Ordinarily, however, small procedures on the face can be done by a



local infiltration with interruption of a conical area by circumferential injection focusing at a point deep to the center of the field.

*Special Areas.* An area which is particularly prone to infection, such as carbuncle, especially in the diabetic patient, is the back of the neck and the corresponding thick skin of the interscapular region. These can be incised by cruciate incision or completely excised under local anesthesia if one utilizes a wide circumferential injection undermining the infected area to a focal point at the center of the carbuncle, thus placing a conical barrier beneath it. This is necessary because of the bilateral innervation near the midline and the fact that the first posterior divisions of the spinal and cervical nerves are given off just after they emerge from the spinal foramina making them difficult to reach except by paravertebral injection. Usually 20 to 30 cc. of novocain are enough.

Fractures of the long bones can be set in satisfactory and painless fashion by the injection of 30 to 60 cc. of novocain into the hematoma between the broken ends. Of course, the fracture must be recent, preferably within the past twenty-four hours, so that sufficient diffusion of the solution can occur and, again, it is important to allow fifteen to twenty minutes to elapse before testing the anesthesia. This

does not seem in any way to interfere with healing, and is a very useful and simple procedure.

Lesions of the breast which are too large for local injection, even radical breast amputation, can be done under a regional block of the corresponding intercostal nerves from first to eighth inclusive, injection into the axilla to interrupt the long thoracic and long subscapular nerves, a barrier along the infraclavicular space deep into the pectoral muscles to interrupt the anterior thoracic branches from the brachial plexus, and a superficial barrier along the midline vertically to interrupt the slight overlap which occurs from the opposite side. Thus regional block of this sort would be required for amputation, plastic operation on the breast and drainage of suppurative mastitis. Simple procedures such as aspiration of a cyst, biopsy and enucleation of fibroadenoma can be done with local injection only.

#### SUMMARY

The advantages of local anesthesia, particularly for the diabetic patient are pointed out.

The necessary anatomic knowledge is briefly reviewed.

The instruments, technic and other useful details are discussed.



# INTRAPERITONEAL INJECTIONS

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THE history of intraperitoneal injections is largely one of decreasing popularity and indications. The prevalence of the skill and facilities necessary for intravenous therapeutics has, in most centers, made intraperitoneal administration of fluids, blood and drugs a substitute procedure. The combination of pneumoperitoneum and x-ray examination in the diagnosis of abdominal lesions,<sup>1,2</sup> though never widely practised, has given way to direct examination by means of the peritoneoscope<sup>3,4</sup> in many instances. Vaccination of the peritoneal cavity by the intraperitoneal injection of vaccine has been soundly recommended as a prophylactic measure against the occurrence of peritonitis following surgery of the large bowel.<sup>5-9</sup> A recent report,<sup>10</sup> however, suggests that the use of sulfanilamide may prove to be a valuable procedure in preparing the patient to deal with contamination of the peritoneal cavity sustained during surgery of the various abdominal organs. Only one indication seems to be becoming more important: that is, the intraperitoneal injection of gases as a revocable procedure in the collapse therapy of pulmonary tuberculosis.<sup>11-15</sup> In spite of the obvious general trend away from the use of intraperitoneal injections, there will be some instances when this procedure may be useful. It is with these occasions in mind that the following material concerning the uses and dangers of intraperitoneal injections is presented.

## TECHNIC

Various sites have been recommended: the midline below the umbilicus; the lateral border of the rectus muscle;<sup>16</sup> a point one inch to the right of the umbilicus;<sup>17</sup> and just above and to the left of the umbilicus.<sup>18</sup> The

region about the umbilicus is usually chosen because no fixed viscera or fixed loops of bowel are normally encountered there. Small bowel underlying this area is normally free to move in any direction to escape puncture by the needle. It is desirable to avoid the round ligament of the liver, the urachus, the inscriptions tendineae, the cords representing the former hypogastric arteries, and the inferior epigastric arteries. (Fig. 1.) These structures are less liable to be encountered if the puncture is made through a point one inch on either side of the midline and an inch above the level of the umbilicus. These measurements are applicable to adults. In children the distances are decreased but corresponding sites are used.

After ascertaining that the bladder is empty, the skin is prepared with a fat solvent such as ether or benzine, and this is followed by application of a 3.5 per cent solution of iodine in alcohol. The area is draped in a sterile manner. Local anesthesia, by means of infiltration with a 1 per cent solution of novocain, is induced down to the peritoneum. The skin may then be pierced with a sharp pointed scalpel to facilitate the introduction of an 18 gauge needle having a rather short bevel (about 45°) and a slightly dull point. Passage through the peritoneum is easily detected by the sudden loss of the sense of resistance. Daniels and Eisele<sup>15</sup> have attached the needle to a syringe filled with air, and as the peritoneum is approached, pressure is made upon the plunger of the syringe. As soon as the needle pierces the peritoneum, both the "give" of the needle in passing through it and the release of pressure against the plunger in the syringe signify that the peritoneal cavity has been entered. In children the abdominal wall may be

"pinched up" in order to displace loops of bowel, thus avoiding puncture of the intestine.

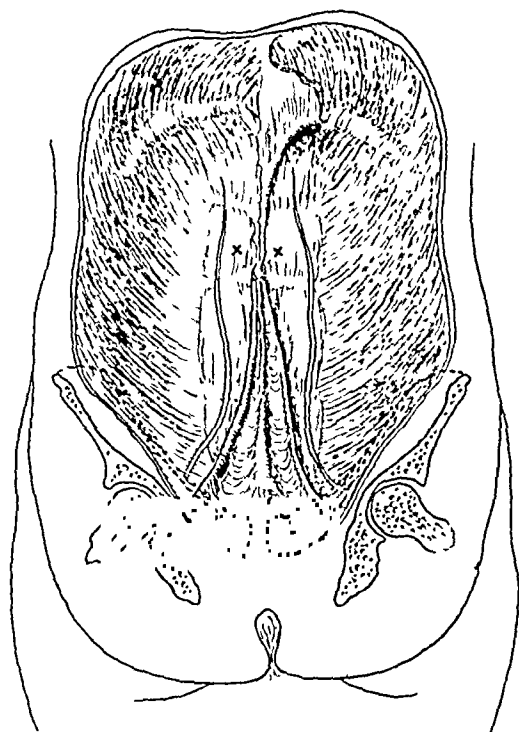


FIG. 1. View of the inner surface of the anterior abdominal wall showing the structures to be avoided in intraperitoneal puncture and indicating (x) the sites at which punctures will be least liable to encounter these structures.

#### DANGERS AND COMPLICATIONS

One gains the impression from the literature that intraperitoneal injection is rarely complicated by accidents or undesirable sequelae. However, it is possible that many unhappy experiences with this procedure have remained unrecorded. At any rate, passing a needle through the abdominal wall is not totally devoid of risk.

Perforation of the intestine is the first danger to be kept in mind. This risk was emphasized by Blackfan and Maxcy<sup>18</sup> in 1918, and again by Ravenel<sup>19</sup> in 1933. The latter author reported a fatal instance of septic peritonitis following puncture of the intestinal tract sustained during the course of intraperitoneal injection. The opening in the bowel resulting from puncture by a needle of the size ordinarily used in performing intraperitoneal injection probably

closes spontaneously in most instances by herniation of mucosa or sealing off with plastic exudate.

Puncture of the intestine is more liable to occur when loops of bowel are not free to escape the needle, as may obtain in the presence of peritoneal adhesions or distention of the bowel. The thin bowel wall in the latter situation increases the possibility of perforation. The presence of ascites with an already increased intra-abdominal tension and decreased absorptive power of the peritoneum is an obvious contraindication for the intraperitoneal injection of fluid or blood. Ravenel<sup>19</sup> has called attention to the possibility that the hypogastric arteries may remain unobliterated for longer than the usual two or three months.<sup>20</sup> He reported two instances of serious hemorrhage following damage by puncture to such vessels.

Grulee<sup>17</sup> considers the presence of an acute infection a contraindication for intraperitoneal transfusion. He expressed the opinion that disturbance or damage to the peritoneum may cause a locus minoris resistentiae and may subject the peritoneum to bacterial invasion via the blood stream. It seems reasonable to suggest that the same risk may exist in the intraperitoneal injection of saline and dextrose solutions under similar circumstances.

#### AGENTS USED

In infants and children the agents introduced into the peritoneal cavity most frequently have been saline<sup>18</sup> and dextrose<sup>21</sup> solutions to combat dehydration and to supply carbohydrate. These fluids should be given at a temperature of 105°F. The amount given varies from 100 to 400 c.c., depending upon the size of the patient. Fluids may be given to the point of mild distention, which soon disappears, but marked distention should be avoided because of the decreased absorption by the peritoneum and upward displacement of the diaphragm. The absorption of amounts of fluid up to 200 cc. should occur in four to five hours. Thus, several punctures daily

may be done, permitting the introduction of sufficient fluids to maintain a satisfactory fluid balance.

Intraperitoneal transfusion of citrated blood was studied in animal experiments by Siperstein and Sansby.<sup>22</sup> They showed that both cells and serum were absorbed by the peritoneum. Siperstein,<sup>23</sup> in 1922, reported good results from the clinical use of the method. It is not widely practised at the present time in most centers because the objection has been raised that the absorption of citrated blood by the peritoneum is liable to be too slow to be effective. This route obviously has no place in the treatment of shock and hemorrhage, in which prompt restoration of a satisfactory volume of circulating blood is urgently needed. However, it may be used in the correction of anemia when lack of facilities or sufficient skill do not permit intravenous transfusion. Cross-matching of the blood is necessary for intraperitoneal use, just as it is for the intravenous method of transfusion. The amount of blood given is based on the same factors as is the use of saline and dextrose solutions intraperitoneally. Either the gravity method or the multiple syringe (100 cc. syringes) method may be used.

Stein and Stewart<sup>1</sup> have traced the history of the use of pneumoperitoneum combined with roentgenography in the diagnosis of intra-abdominal lesions. The outlines of the liver, spleen, kidneys and gallbladder, and the presence of intraperitoneal adhesions may thus be demonstrated. With the increasing use of the peritoneoscope, direct inspection will probably replace the combination of pneumoperitoneum and roentgenography, but the latter procedure may still have a limited field of usefulness.

The therapeutic use of oxygen injected intraperitoneally in patients with tuberculous peritonitis has been described by Stein<sup>24</sup> but has not been widely practised. The uncertainty of the response and the difficulty of determining the presence and location of adhesions will deter many from attempting this form of therapy.

Inflation of the peritoneal cavity for its collapsing effect on the lungs was first used by Vajda<sup>11</sup> in 1933. The reports of Banyai,<sup>12,14</sup> Trimble and Wardrip,<sup>13</sup> and Daniels and Eisele<sup>15</sup> indicate its definite value in the collapse therapy of pulmonary tuberculosis. An average of 600 to 700 cc. of oxygen are used, and refills of approximately 500 cc. are given weekly. During the production of artificial pneumoperitoneum for either diagnostic or therapeutic purposes, the additional risk of air embolism is to be added to the hazards of intraperitoneal injection already mentioned.

The mortality from peritonitis following surgery of the large bowel prompted the development of peritoneal vaccination with colibactragen, a suspension of *B. coli* in tragacanth prepared according to the method of Steinberg.<sup>9</sup> Borgen and Rankin<sup>5,6</sup> and Potter and Collier<sup>8</sup> obtained good results with this method, but the use of sulfanilamide as a prophylactic measure in abdominal surgery, as described by Lockwood and Ravdin<sup>10</sup> may result in a decrease in the use of peritoneal vaccination.

#### SUMMARY

Although it is apparent that the popularity and general indications for intraperitoneal injections are decreasing, there remain some instances when this procedure may be useful. Therefore, its technic is described, the dangers and possible complications are emphasized, and some of the essential points in the intraperitoneal injection of fluids and gases are presented.

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# INTRAVENOUS INJECTIONS AND INFUSIONS

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THE discovery of the circulation of blood by Harvey, announced in 1628,<sup>1</sup> was soon followed by attempts to introduce various substances into the blood stream. Sir Christopher Wren is given credit<sup>2</sup> for performing in 1657 the first intravenous injection of a drug in man. According to Matas,<sup>3</sup> the use of intravenous saline solution was first successfully practised by Joenichen of Moscow in 1830. Matas,<sup>4</sup> in 1891, reported good results in surgical patients treated for shock, hemorrhage or "exhaustion" by intravenous saline infusion. Extensive studies of the cause of unfavorable reactions following intravenous therapy<sup>5-9</sup> and of the mineral and water metabolism of the body<sup>10-13</sup> have made possible the safe and rational intravenous administration of relatively large amounts of fluid.

Intravenous injection is the term applied to the introduction of small amounts of solutions (1 to 20 cc.), usually by means of a syringe. Intravenous infusion indicates the introduction of amounts of fluid larger than can ordinarily be contained in a syringe. Fluids given in this manner are usually allowed to run into the vein by the force of gravity although their introduction may be hastened by "milking" the rubber delivery tube.

The indications for the introduction of solutions directly into the blood stream may be classified as follows:

1. To obviate a period of absorption.

(A) When immediate or early effect is desired, as in:

1. Drug therapy (epinephrine, insulin, dextrose, morphine, barbiturates and antisera).
2. Fluid therapy (saline, dextrose, buffer, or acacia solutions used to restore effective circulating

blood volume in shock or hemorrhage and to correct dehydration, alkalosis or acidosis).

(B) When a definite amount of a substance is wanted in the blood stream (kidney and liver function tests and gallbladder visualization).

(C) When the moment of entrance of a substance or solution into the blood stream must be known (as in determinations of circulation time).

11. To allow parenteral administration of substances which would cause pain or damage to the tissues if given subcutaneously or intramuscularly (hypertonic saline, dextrose, or sucrose solutions, arsenical preparations, calcium chloride or calcium gluconate).
111. To introduce substances for the purpose of damaging the wall of a vein, as in varicose veins (sodium morrhuate, concentrated sugar solutions, quinine and urethane, monolate, quinine and urea hydrochloride).

## TECHNIC

The veins commonly used for intravenous injections and infusions are shown in Figure 1. In infants, injection into the superior longitudinal sinus is to be done only when attempts to use all other intravascular routes have failed. By far the safer procedure is to expose a vein which has a constant location, even though it may not be visible or palpable with the skin intact. For intravenous injections which last only a few minutes, even an uncomfortable position may be maintained if it provides an easy approach to a suitable vein. On the contrary, when infusions which may run for a few hours or veno-

clyses which may be continued for days are to be given, a comfortable position for the patient must be provided. Immobiliza-

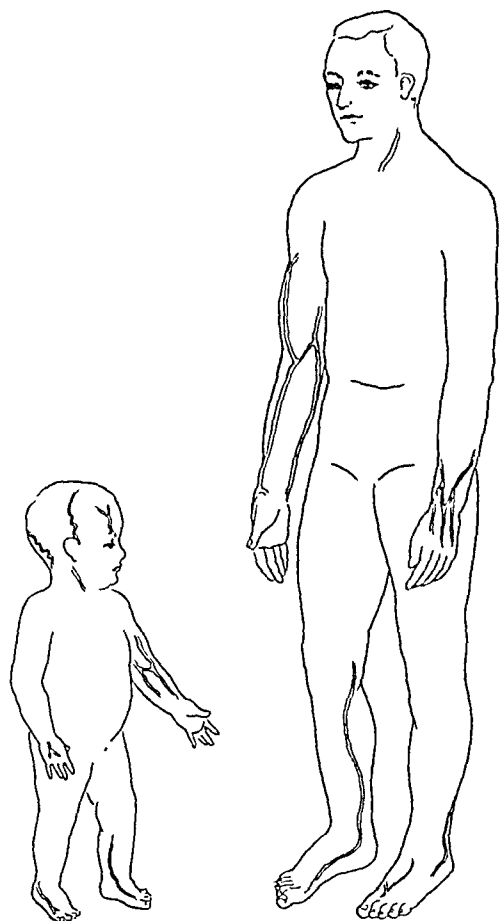


FIG. 1. Veins usually accessible for intravenous therapy in children and adults.

tion of the arm in complete extension at the elbow with the palm turned upward causes discomfort in a short time. A comfortable position is shown in Figure 2.

In performing venipuncture, the skin is prepared by using a fat solvent, as ether or benzine, followed by 3.5 per cent tincture of iodine. A tourniquet or the cuff of a blood pressure apparatus is applied to render the vein visible or more prominent but often the vein must be located by palpation alone. A 19 or 21 gauge needle is suitable for the venipuncture. Blunt needles frequently tear the vein wall and therefore less difficulty will be encountered if a sharp needle with a moderately long bevel is used in conjunction with a practised

sense of touch. The patency of the lumen of the needle and the absence of a bur at the tip should be demonstrated before attempting to enter the vein. Local anesthesia, if desired, is easily accomplished by intracutaneous and paravenous infiltration with 1 per cent novocain solution. The vein may be obscured temporarily but massage will soon disperse the injected anesthetic solution and a painless puncture is then possible.

As a rule, the skin is pierced separately unless it is thin. If the skin is thick and resistant, a small puncture wound through which the needle is passed may be made with a bistoury. The needle, with the bevel up, should then be directed at an angle of about 45 degrees from the vein. (Fig. 3.) After the needle pierces the skin, the needle is turned so that the bevel is down, and the approach is then made from the side, with the tip of the index finger of the free hand supporting the opposite side of the vein. (Fig. 4.) The thumb further immobilizes the vein by stretching the overlying skin gently. In this way the vein may be immobilized so that it will not escape the thrust of the needle. Blood should enter the needle spontaneously if the venous pressure is within normal limits. The sensation of piercing the vein wall is sufficiently definite to render infrequent the mistake of puncturing the opposite wall, which should happen only in small veins, where there is a disproportion between the size of the vein and the size of the needle. When difficulty is encountered in entering a vein, another site should be used, as the trauma attendant on repeated attempts is conducive to early clotting of the blood which enters the needle when the puncture is finally accomplished. After the tip of the needle has entered the vein, the angle at which the puncture was made is decreased. In giving infusions, the needle should be passed upward into the vein for a distance of 1 to 2 cm. so that only a great disturbance will dislodge it. (Fig. 3.) When it is ascertained that no air is present in the tubing, the introduction of the solution

should begin at once as delay at this point may permit clotting.

When infusions are given, the needle

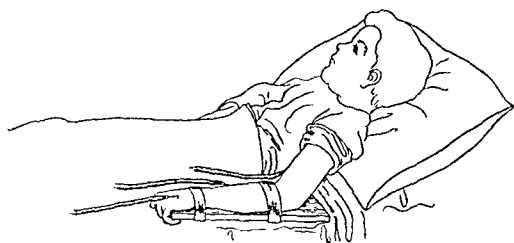


FIG. 2. Arm in position naturally assumed by a patient in the supine position. Needles in three commonly used veins. The needle may be introduced while the palm is upward and if it is properly inserted into the vein it will not be disturbed by the change to this comfortable position.

should be fastened in a position which does not cause angulation of the vein and which does not permit the bevel to rest against the vein wall. (Fig. 3.) When irritating substances are injected into the blood stream, the syringe should be rinsed with blood so that a damaging concentration of the solution will not leak from the opening in the vein when the needle is withdrawn. Upon removing the needle, pressure and massage should be applied immediately over the site of puncture to prevent hematoma and to stimulate contraction of the vein to aid in closing the puncture wound in its wall.

In patients suffering from shock, in whom the veins are collapsed, or in debilitated patients with small, thin-walled veins, it is often necessary to expose a vein by incising the overlying skin. No hesitancy should be entertained about doing this in such patients, as it makes the introduction of fluids into the vein almost a certainty and rarely does any difficulty arise from the ligation of the vein. Gallie and Harris<sup>14</sup> recommend the use of a small vein when direct exposure is necessary as clotting is less liable to occur in the presence of the increased rate of flow at the site of introduction when small vessels are used.

The technic of exposing a vein follows established surgical principles and is accomplished as shown in Figure 5. The skin

is prepared by using a fat solvent, as ether or benzine, followed by 3.5 per cent tincture of iodine. Suitable sterile drapes are

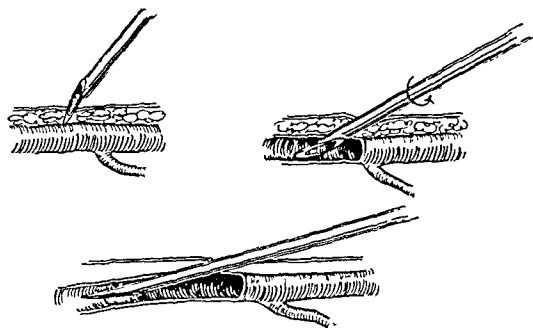


FIG. 3. Vein wall pierced with needle at an angle of 45 degrees to avoid passing the needle along the sheath of the vein. After the tip is introduced the angle is decreased, the bevel turned down and the needle passed into the vein for a distance of 1 to 2 cm.

not only actual protection for the area involved but also serve as reminders that strict asepsis is to be maintained throughout the entire procedure. Local anesthesia is entirely satisfactory, the infiltration of the skin and the subcutaneous and paravenous tissues being somewhat more extensive than that described for simple venipuncture. A transverse incision  $\frac{1}{2}$  to 2 cm. long, depending on the amount of subcutaneous tissue present, is made directly over the vein. The subcutaneous tissue is separated from the vein by blunt dissection parallel to the vessel, using a small curved hemostat. The entire circumference of the vein must be freed for a distance of about 1 cm. before it is encircled by two ligatures of fine silk or catgut. The distal ligature is tied. Traction on the proximal ligature or the use of a small bulldog blood vessel clamp will prevent loss of blood when the vein is opened. By upward traction on both ligatures the vein is immobilized. A fine pointed bistoury is passed transversely through the wall of the vein at two opposite points and is then drawn distally and upward to make a flap in the vein wall. An alternate method with fine scissors may be employed. By grasping the tip of the flap and the ends of the incision in the vein with fine mosquito forceps, a suitable cannula may be intro-



duced and tied in place, using a bow knot. The necessary skin sutures are put in place while the local anesthetic is still effective.

ministration, fresh or preserved blood, plasma or serum may be substituted for other fluids.

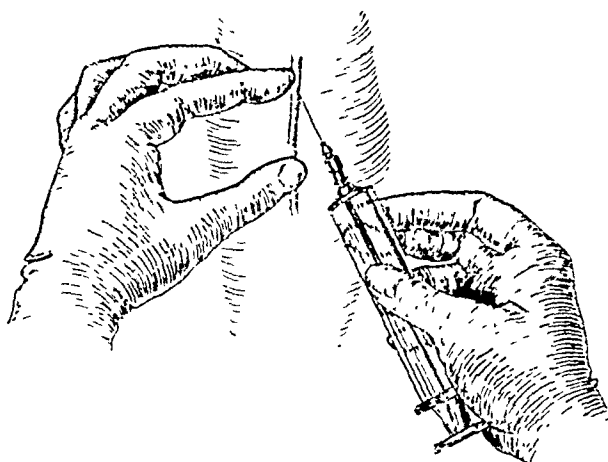


FIG. 4. Technic of venipuncture. Vein is immobilized by support from the tip of the index finger and by stretching the overlying skin with the thumb. The coordinated use of tactile sense in both hands is made possible by palpating the vein with the tip of the index finger of one hand and grasping the syringe in the fingertips of the opposite hand.

When the infusion is completed the bow knot is untied, the cannula is removed and the ligature is tied permanently. The skin edges are approximated by the stitches which are already in place.

In instances in which the necessity for the intravenous administration of fluid is expected to be present for many days, the most distal part of a vein should be used first so that local obliteration by ligature or by thrombosis will not interfere with the use of the proximal portions. The intravenous administrations may be continuous, as first practiced by Matas<sup>3</sup> and so staunchly recommended by Horsley<sup>15</sup> and Hendon.<sup>16</sup> Venoclysis, the name popularized by Hendon for this form of therapy has been used for as long as nineteen days without clotting, but the average time it will run uninterruptedly is about five days. A flow of 500 cc. per day is regarded as sufficient to prevent clotting.<sup>14</sup> Saline solution in physiologic concentrations has been found to be associated with thrombosis in venoclysis less frequently than dextrose solution. At any time, in either the interrupted or the continuous method of ad-

At present it is well recognized that bacterial contamination is usually the cause of "reactions," and the temperature of solutions and the rate of their administration now receive less attention as possible causes. The rate of administration varies according to the solution. Drugs and chemicals should be injected slowly enough so that an undesirable concentration will not be present to damage the vein wall or to reach vital centers and cause an unfavorable response. Some drugs such as the barbiturates are given at a rate not exceeding 1 cc. per minute to guard against overdosage.

In giving larger amounts of fluid, the rate of administration is governed by several factors. By far the most important ones are the capacity of the vascular system and the ability of the heart to propel the increasing volume of blood. In shock or hemorrhage, the prompt restoration of an effective circulating blood volume is desirable. Under such circumstances, the fluid should be given at a rate of from 20 to 40 cc. per minute until the pulse and blood pressure show satisfactory improvement.

The rate may then be reduced. Gilligan et al.<sup>17</sup> have shown that in patients not in shock the greater increases in total blood

monary edema or edema of nephritic origin should not be given fluids intravenously. The question of how much fluid to give

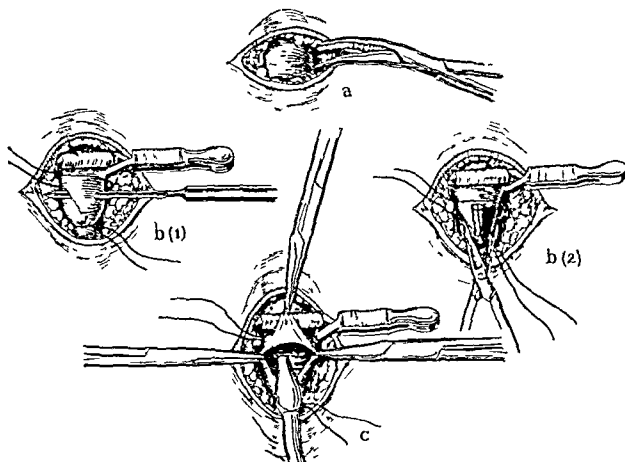


FIG. 5. Technic of exposing a superficial vein for insertion of a needle or a cannula. Cutting instruments are used only to divide the skin and to open the vein. The vein is isolated entirely by blunt dissection. With this technic a cannula slightly larger than the vein can be inserted.

volume occur with the faster rates of administration and that these increases persist longer. For simple fluid replacement a flow of 200 to 400 cc. per hour is generally regarded as safe in adults without cardiovascular disease. If a 10 per cent dextrose solution is used, it may be given at a rate of 300 to 500 cc. per hour with an average loss of only 5 per cent of the dextrose by "spilling over" into the urine.<sup>18</sup> According to Schwentker,<sup>19</sup> 10 cc. of solution per pound of body weight may be given intravenously to children up to four years of age. In severe dehydration in infants under two years, the amount may be increased to 15 to 20 cc. per pound. It should be given at the rate of 3 cc. per minute.

Aside from known idiosyncrasies and contraindications based on the nature of the substance to be injected, the contraindications for intravenous therapy are relatively few. They concern chiefly those states in which the body already has too much water, either generally or in one particular area, or when there will be difficulty in removing water if it is given in excess quantities. Thus, patients with severe heart or kidney disease, those in congestive failure, and those with pul-

travenously is too extensive to discuss here except to say that as a rule it is safe to introduce 3,000 cc. of fluid daily, according to a well spaced schedule, in patients not having a basis for the above contraindications.

#### DANGERS AND COMPLICATIONS

The dangers and complications may be local, as slough from paravenous injection of irritating substances, thrombosis of the vein or infection. The general dangers and complications are more numerous and more serious. In the administration of relatively large amounts of fluid, pulmonary edema is one of the most frequent undesirable results. Pulmonary embolism and air embolism are infrequent. Anaphylactoid reactions must be regarded as a source of danger in intravenous serum therapy. In patients who have lowered concentration of serum protein from any cause, the possibility of producing edema is always present. Continuous drip infusion may deplete the patient's protein stores<sup>20,21</sup> if continued too long, or it may cause pulmonary edema in a patient who would tolerate interrupted administration of smaller amounts of fluid. Edema from salt retention may occur in

patients with arteriosclerotic changes in the kidneys. Dependent edema is a warning signal that too much fluid or too much salt is being given and this sign should not be disregarded, as internal edema will soon follow. Dilatation of the heart may occur from the too rapid administration of fluid and its onset is heralded by a dry cough.<sup>22</sup>

#### SUMMARY

The indications for intravenous injections and infusions are classified. Technics for venipuncture and venoclysis are described. Some essential points dealing with fluid replacement are reviewed. The more common dangers and complications of intravenous therapy are presented.

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# INTRAVENOUS ANESTHESIA IN MINOR SURGERY

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THE ideal anesthetic agent for use in minor surgery is one which meets the following qualifications: (1) It must have a reasonable margin of safety; (2) anesthesia must be induced with speed and yet with comfort to the patient; (3) the after effects of the agent must be minimal; (4) its administration should not be too complicated, and (5) it should, if possible, be nonexplosive. Sodium pentothal has properties which meet the above requirements. Lundy<sup>1</sup> and his associates at the Mayo Clinic have just reported the use of this barbiturate in more than 18,000 instances from 1934 to 1939 inclusive. It is very interesting to note the growth in the use of this anesthetic at the Mayo Clinic, where more intravenous anesthesia is done than in any other American clinic. In 1934 only seventy-three patients received pentothal sodium; in 1937 the number was 3,810 and in 1939 the drug was used in 5,874 instances.

I<sup>2</sup> first used intravenous anesthesia in the Allgemeines Krankenhaus, Vienna, in the clinic of Dr. Hellmut Kamniker. At that time, in 1933, a few months after its synthesis in Germany, we were using evipan. This drug, which is known as evipal in this country has the following formula: Sodium N-methylcyclo-hexenyl-methylbarbituric acid. Pentothal is sodium ethyl l-methyl butyl thiobarbituric acid. These two drugs are fast acting barbiturates in contradistinction to the slower acting drugs such as sodium amytal, nembutal, luminal, diallyl barbituric acid, pernocton and neonal. The slower acting barbiturates have been shown to give good anesthesia in the majority of cases, but pulmonary edema and bronchopneumonia are complications which make the use of these drugs dangerous. With pentothal, however, we do not see any more postoperative com-

plications than we do with any of the inhalation anesthetics. It is my firm opinion in over 1,000 intravenous anesthetics that I have done, that pulmonary conditions are less frequent after intravenous anesthesia than with any other type. When the time of anesthesia is moderately short, as it usually is in minor surgery, the danger of any complication is, of course, correspondingly less.

Patients invariably state that they like pentothal anesthesia. Many patients who have taken ether or nitrous oxide are a little afraid to take inhalation anesthesia again, and they worry about the nausea and vomiting which may have been severe in their particular cases. Some patients may have a cold or feel indisposed, and yet an anesthetic must be given for perhaps a carbuncle, simple fracture, dislocation or to drain a felon. In minor surgery I would list the following procedures as satisfactory for pentothal anesthesia: (1) To open a boil; (2) biopsy of a lymph node; (3) to remove a small tumor, cyst or wart from the skin; (4) to dilate an abdominal sinus for better drainage; (5) to set a simple fracture; (6) to reduce dislocations; (7) to excise a thrombosed hemorrhoid; (8) cystoscopy and ureteric catheterization; (9) dilatation and curettage of the uterus; (10) to control convulsive states such as dementia of various kinds and delirium tremens; (11) to treat fresh burns, and (12) to suture lacerations.

The dangers of the intravenous use of pentothal are: (1) respiratory depression; (2) cyanosis; (3) fall in blood pressure; (4) liver damage, and (5) injury to the tissues by extraveneous solution. Regarding the first of these points, all of which must be watched most carefully, it is a *sine qua non* to intravenous anesthesia (just as with inhalation) that oxygen be immediately

available. While in the great majority of cases no oxygen or only a little (especially in minor procedures) is needed, it must be placed in the room before the operation starts. I have had to maintain artificial respiration in only a very few cases, and in those instances the pentothal had been used in large dosages. Cyanosis will be present in greater or less degree frequently. In 23 per cent of my cases I have found slight to severe cyanosis. This is due in part to the decrease in the excursion of the respiratory cage, a phenomenon which occurs in 85 per cent of all intravenous anesthetics; but if watched for and if treated by the administration of oxygen as soon as it starts, there seldom will be any severe embarrassment to respiration. A fall in blood pressure of usually 20 mm. of mercury occurs in every instance. This is transitory and there is a gradual recovery period which becomes complete with the return of consciousness. I have never seen any catastrophic fall in blood pressure with pentothal. In fact, in major surgery, I frequently use pentothal intravenously together with spinal anesthesia, although in these instances less pentothal is used than if the intravenous method alone was being employed. Jaundice is a rare complication and I have seen only two cases which might be attributed to pentothal. Both of these patients had a large amount of the drug. One was a man, aged 80, who had a perineal prostatectomy under 1,275 mg. in fifty minutes, and no other anesthesia was used. The jaundice lasted only two days, came on thirty-six hours after operation, and as far as could be ascertained, was not of serious import. If pentothal is accidentally injected into the tissues around the vein, there will be moderate to severe inflammation, sclerosis and ulceration, depending upon the amount. Obviously, this is a matter of improper technic in inserting the needle. I like to use the veins upon the dorsum manus, the cubital fossa, the accessory cephalic and the vein which is always found over the internal malleolus. One should use a No. 19 needle, although a No.

20 or even No. 22 may be used in very small veins.

If one is unfamiliar with intravenous anesthesia, he should first use the drug in cases which are to be of short surgical duration and upon patients who are in good physical condition. There is no set formula in the administration of this drug. Experience, and experience alone, will tell the anesthetist how much to use and in what cases. I have used as much as 3,500 mg. as the only anesthetic in the removal of four ribs in a severe case of empyema, and I have used as little as 200 mg. for the removal of a fingernail, or even of a carcinoma by cautery in a second stage Mickulicz operation. Its use in major surgery is discussed in a recent article by the author.<sup>3</sup>

#### ADMINISTRATION OF PENTOTHAL SODIUM INTRAVENOUSLY (DR. LUNDY'S TECHNIC)

Pentothal sodium comes in 1 gram ampoules, and is a white powder which is easily soluble in water. The following material is necessary for mixing up the solution and preparing the syringes:

1. 50 cc. distilled water
2. Sterile glass 50 (fifty) cc. quantity
3. An ampoule of pentothal sodium
4. Two 20 cc. glass (sterile) syringes with glass plungers
5. Two No. 19 needles
6. One No. 20 needle (in case of small vein)
7. Alcohol 70 per cent for sterilizing skin
8. Tourniquet
9. Sterile towels to drape arm
10. Arm board and tape
11. Oxygen tank and mask
12. Saw to cut ampoule

First, open the ampoule of pentothal. Then suck up 20 cc. of distilled water into one of the syringes and inject this into the ampoule thereby dissolving the contents (by barbotage). This will produce a 5 per cent solution of pentothal. Lundy has clearly shown that the 2½ per cent solution

is the better strength to use, and this means, of course, that the 20 cc. of 5 per cent solution must be added to 20 cc. of distilled water in the glass cup. This will make two 20 cc. syringe-fulls of 2½ per cent solution of pentothal each containing 500 mg. of the drug. Before administering the solution it is most important that the patient be given a sedative such as nembutal grains 1½ about one-half hour before the operation. Morphine, too, should be given, from ⅓ to ¼ grains depending upon the strength and size of the patient. If the pentothal is given without the preoperative medication outlined, it will be necessary to use from 25 to 100 per cent more solution in order to obtain the desired anesthesia. Insert the needle into the selected vein and ask the patient to start to count slowly and in good voice. Inject 4 cc. slowly (5 seconds); wait 20 seconds and inject an additional 2 cc. Usually at about the count of fourteen to eighteen the patient will sigh, or the voice will become softer, or he will count more slowly. It may be necessary to inject a total of from 8 to 10 or even 12 cc. in a period of two to three minutes before the patient is asleep. Just before the surgeon starts to operate introduce 2 to 3 cc. of the drug and watch the patient carefully for movements of the hands, eyebrows, etc. It is often possible for the surgeon to operate upon a minor case without having the patient completely out. It is quite unnecessary to put the patient into complete, deep anesthesia, and this is the most important stage of the procedure. Keep the patient's chin up and establish a good airway; if necessary, use a wire airway. Laryngeal spasm is an important complication which may come on if one does not keep the respiratory tract clear. For this reason it is always wise to give atropine ⅓<sub>150</sub> whenever one can do so. If spasm does supervene, put gentle pressure upon the chest every six seconds and give oxygen freely. In testing the level of anesthesia, it is a good idea to pinch the skin of the axilla just before the surgeon is to begin.

For dilatation and curettage the usual dose is about 400 to 700 mg. in a space of twelve minutes. To open an abscess one should give 250 to 450 mg. With doses such as these, the patient will awaken in five to fifteen minutes. It is better not to awaken the patient, but let him sleep for a few minutes after the procedure has been completed. When large doses, anything over 1,200 mg., have been given, it is not at all unusual for the patient to sleep for two to eight hours postoperatively.

It is an absolute fact that patients like intravenous anesthesia better than any anesthetic agent that has hitherto been devised. The majority of them will tell you spontaneously how much they enjoyed taking it. This is especially so when there has been a previous unpleasant experience with ether or some other inhalant.

A surgeon should under no circumstance give this anesthesia and then operate upon the patient himself. I am positive that the best manner to give the drug is for the anesthetist to stand at the operating table, keep his finger upon the needle in the vein and introduce the solution as he sees fit. I am definitely opposed to the administration of pentothal by sticking the needle into a saline that is running in, or by fastening the pentothal syringe to the saline tube by means of a Y-connection. The giving of pentothal should be the complete work of one man, and only by keeping his fingers on the syringe and the vein being used, does he have complete and positive control of the anesthetic. In this way the anesthetist will always know exactly how much has been given, and having followed the case along throughout the entire procedure he will be qualified to tell just how much more of the drug the patient needs. If an intravenous injection is needed, another vein in the other arm or leg should be used.

#### CONCLUSIONS

Intravenous anesthesia is of great value in minor surgery for the following reasons:

1. It is easy to administer if certain rules are followed.

2. It is nonexplosive and may be used in the presence of electrocautery and flame.

3. There are practically no after effects; nausea and vomiting are rarities.

4. It can be used for short procedures, the patient being able to walk home (accompanied) afterwards.

5. It has as wide if not a wider range of safety as has ether.

6. Its greatest use is in cases in which complete deep relaxation is not required.

7. The 2½ per cent solution administered according to the Lundy technic is the best method when using sodium pentothal.

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ONE of the greatest difficulties of spinal analgesia lies in the drop in blood-pressure that is produced . . .

From—"Rose & Carless Manual of Surgery," Edited by William T. Coughlin (The Williams & Wilkins Company).

# PARACENTESIS ABDOMINIS

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**P**ARACENTESIS abdominis, puncture of the abdominal cavity, may be done for the following purposes: (1) To remove ascitic fluid for palliation; (2) to remove fluid from the peritoneal cavity for gross and microscopic examination as an aid in diagnosis; (3) to produce pneumoperitoneum; (4) to introduce a peritoneoscope for direct visualization of the peritoneal cavity and its contents; and (5) to inject various therapeutic agents into the peritoneal cavity.

Perforation of a viscus and hemorrhage are the serious complications of paracentesis abdominis and are most likely to occur if puncture is done at a point at which the bowel is fixed to the abdominal wall by adhesions or at which a viscus is fixed by normal peritoneal attachments. The site selected for puncture should be away from the regions of fixed viscera. The site of puncture usually chosen for removal of ascitic fluid is below the umbilicus in the median line or lateral to the course of the deep epigastric vessels. The bladder should be empty at the time of operation. Puncture should not be performed if intraperitoneal adhesions are suspected or known to be present. In instances in which adhesions are present and the removal of fluid is necessary, it is better to incise the abdominal wall and carefully open the peritoneum under direct vision. The reports of Ruddock<sup>1</sup> and Pflaum<sup>2</sup> indicate the frequency and seriousness of this complication when paracentesis is done blindly. Pflaum found ten cases of peritonitis incident to paracentesis among 1,000 fatal cases of peritonitis. Ruddock reported eight instances of perforation of the bowel in 500 patients upon whom peritoneoscopy was performed.

If the bowel is perforated with a needle, it is unlikely that serious trouble will follow, as the opening is usually promptly plugged by mucosa and sealed over by peritoneum. Patients in whom such an accident is suspected should be kept under observation in bed for a few days and peristalsis during this period should be limited by proper care. If the bowel is perforated with a trocar, it is best to operate immediately and close the opening in the bowel wall.

## REMOVAL OF ASCITIC FLUID

Paracentesis for the removal of ascitic fluid is a procedure that is frequently performed. Fontaine<sup>3</sup> and Marbel<sup>4</sup> have described special cannulas for this purpose. Perforation of the bowel is unlikely when paracentesis is done for ascites due to liver, kidney or heart damage because intraperitoneal adhesions are usually absent. After repeated tapplings, adhesions may form at the sites of puncture and the danger of perforation of the bowel then increases. In ascites associated with tuberculous peritonitis, perforation of the bowel incident to abdominal puncture is more likely to occur. Occasionally shock, and rarely death, follows rapid removal of large quantities of ascitic fluid. A possible explanation for this complication is found in the studies of Brams, Katz and Kohn.<sup>5</sup> They observed that after release of marked abdominal distention which had been present for some time the arterial pressure dropped as much as 40 mm. of mercury. The gradual withdrawal of fluid, the application of a tight binder as the fluid is being removed and the replacement of fluid by air are precautions that may be exercised to prevent this complication.



As long ago as 1923, Maes<sup>6</sup> made a plea for more frequent exploration, through a suitable incision, of patients with ascites. He stated, "In all such cases the underlying pathology will be rendered less obscure and the patient's chances of complete or partial relief materially improved if exploratory laparotomy is substituted for simple paracentesis."

#### DIAGNOSTIC PUNCTURE

Denzer,<sup>7,8,9</sup> Neuhof and Cohen,<sup>10</sup> and Johnston<sup>11</sup> have reported the use of puncture of the abdomen for diagnostic purposes. In this procedure, puncture of the peritoneum is performed with an 18 or 20 gauge needle and aspiration done. If fluid is found, its gross and microscopic characteristics are studied. This procedure is considered a valuable aid in the diagnosis of obscure acute intra-abdominal disease and is particularly valuable in the diagnosis of pneumococcal and streptococcal peritonitis, conditions in which operation is not the treatment of choice. Gross blood or bloody fluid is significant in traumatic cases. In rupture of the bladder, the fluid has the characteristic odor of urine. In acute pancreatitis, a beef-juice-colored fluid with an oily appearance may be found. A yellow fluid with a sour odor has aided in the diagnosis of a ruptured peptic ulcer. Microscopic study of a stained smear should give sufficient information for the diagnosis of streptococcal or pneumococcal peritonitis.

The technic of diagnostic puncture<sup>10</sup> is not difficult and is considered a safe procedure.<sup>9</sup> Negative punctures are of no diagnostic value. Neuhof and Cohen<sup>10</sup> make the following statement in regard to negative puncture: "If in any given case the decision has been reached that operation is indicated, whether for a traumatic or an inflammatory intraperitoneal lesion, operation should be proceeded with absolutely regardless of a negative puncture."

If the diagnosis is clear, puncture is obviously not indicated. It is contraindicated in a chronic or subacute lesion that

may have caused fixation of a portion of the bowel and in acute peritoneal infection in which a mass is present.

#### PNEUMOPERITONEUM

Gas is injected into the peritoneal cavity for both diagnostic and therapeutic purposes. Air, oxygen, carbon dioxide and other gases have been used for the induction of pneumoperitoneum, and the effects of various gases on the peritoneum and general health have been studied. Air is considered satisfactory, but the choice of gas depends on the purpose for which pneumoperitoneum is performed.

*Pneumoperitoneum for roentgenographic studies of the abdomen* was introduced by Weber in 1912 but in this country Stewart and Stein<sup>12</sup> first reported its use in 1919. Very little has been reported on this procedure in the literature during recent years. Sante<sup>13</sup> and Martin<sup>14</sup> have described the technic for this type of study. Martin,<sup>15</sup> in a recent discussion of pneumoperitoneum for diagnostic purposes, commented, "... it has never received the recognition that it deserves."

Pneumoperitoneum is used in the treatment of pulmonary, peritoneal and intestinal tuberculosis. In 1930, Overholt<sup>16</sup> demonstrated experimentally the elevation and immobilization of the diaphragm that is produced by pneumoperitoneum. In 1933, Vajda<sup>17</sup> used this procedure for the treatment of pulmonary tuberculosis. Since then, there have been many reports on the value and use of this form of therapy for pulmonary tuberculosis.<sup>18-23</sup>

Pneumoperitoneum has a limited use in the treatment of pulmonary tuberculosis. Stokes<sup>21</sup> points out that where other measures either fail or cannot be used pneumoperitoneum may be of help in the control of hemoptysis and the reduction of toxemia.

#### PERITONEOSCOPY

Visualization of the peritoneal cavity and its contents by an optical instrument was first reported by Kelling in 1901. Reports of this procedure have appeared occasion-

ally in the literature since that time. Ruddock<sup>24</sup> recently revived interest in this operation and in 1938<sup>1</sup> he reported a series of 500 patients upon whom he had performed peritoneoscopy. He developed and described a peritoneoscope and the technic that he has found so satisfactory. He advocates the use of peritoneoscopy to determine malignancies and their extent of involvement, to differentiate and localize tumor masses, to confirm diagnoses and to obtain biopsies. To be successful, the operator must train himself in the details of the procedure and should be able to recognize and differentiate gross pathologic changes. Peritoneoscopy is contraindicated in patients with inflammatory lesions of the peritoneum.

The complications of peritoneoscopy are commented upon by Ruddock<sup>1</sup> who reported eight instances of perforation of the bowel in 500 patients on whom this procedure was done. In each instance, perforation was recognized at the time it occurred, laparotomy immediately performed, the trocar removed and the perforation closed. One patient in Ruddock's series died from hemorrhage following biopsy of the liver, probably due to incomplete coagulation of the biopsy wound. Thieme,<sup>25</sup> in a critical review of peritoneoscopy, reported a series of fifty patients on whom this procedure was performed. He used the technic described by Ruddock. Thieme considered the method safe and accurate and stated that much of the information usually gained by laparotomy can be obtained by this procedure without the expense or mortality of a major operation.

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# SPINAL PUNCTURE

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QUINCKE of Magdeburg is given credit for the introduction of lumbar puncture. In 1891, he reported the use of lumbar puncture to relieve the symptoms of hydrocephalus. Corning of this country used lumbar puncture six years before, but, as pointed out by Collier,<sup>1</sup> Quincke was the first to make his work known throughout the world. The diagnostic importance of a spinal fluid study was soon recognized and today spinal puncture is a routine procedure in diagnosis and treatment.

New routes have been described by which the cerebrospinal fluid may be withdrawn for diagnostic study, or the subarachnoid spaces reached for therapeutic purposes (cisternal, ventricular), but spinal puncture is still the choice in the majority of instances. The lumbar region is the one usually chosen for puncture because in that location there is no danger of injury to the cord proper. The site usually chosen for the puncture is the third or fourth lumbar interspace, located by drawing a line from the crests of the iliac bones across the spine. The spinal cord becomes the filum terminale opposite the level of the first lumbar vertebra.

The technic of performing spinal puncture is described in detail by Christopher,<sup>2</sup> Labat,<sup>3</sup> and Wechsler,<sup>4</sup> and is omitted here. The diagnostic and therapeutic uses of spinal puncture, the contraindications and the complications will be reviewed in this article.

## DIAGNOSTIC PUNCTURE

When a spinal puncture is performed for diagnostic purposes, a manometric study of the cerebrospinal fluid should be done before fluid escapes or is withdrawn. This is one of the most important procedures in

the study of spinal cord diseases or injury involving the cerebrospinal system. To be of value the test must be carefully performed and the period of compression and manometric readings must be recorded in detail. The recumbent position is preferred. In this position the normal range of pressure is 60 to 180 mm. of water. In the sitting position, pressure values range from 200 to 250 mm. of water. There is a normal oscillation of 2 to 5 mm. of water with each heart beat, and a 4 to 10 mm. change in pressure with each respiration.<sup>5</sup> Straining and coughing elevate the intraspinal pressure. A water manometer is preferable to one of the mercury type because it is much more sensitive to slight changes in pressure and is much easier to sterilize. The normal oscillations concomitant with the heart beat and respirations give assurance that the point of the needle is not blocked. The initial reading should not be recorded until the patient is relaxed. In the recumbent position, a pressure of 180 to 200 mm. of water is probably abnormal and over 200 mm. is considered definitely abnormal.<sup>5</sup>

The Queckenstedt test is done by compressing digitally both jugular veins for ten seconds and recording the manometer reading every five seconds. If there is no block in the spinal canal, the pressure should go up to 300 mm. of water or above in ten seconds, and should drop back to normal within ten seconds after release of the jugular compression. If there is a complete block in the canal between the needle and the brain, there will be no change in pressure readings. A partial block will give only a slight rise; however, it is often necessary to do combined lumbar and cisternal punctures to demonstrate clearly a partial block. The Queckenstedt test depends on the prevention of flow of blood from the

cranium by pressure on the jugular veins. This causes a rise in intracranial pressure which in turn increases the pressure in the spinal canal.

In the presence of lateral sinus thrombosis or of jugular vein thrombosis, digital compression of the jugular vein on the involved side causes no change in intraspinal pressure, whereas compression of the opposite jugular vein causes a rise. The diagnostic significance of these findings is obvious.

After manometric studies have been completed, about 3 cc. of fluid should be collected in each of three sterile test tubes for the examinations to be discussed. Normally, the fluid escapes drop by drop, but if it is under increased pressure it may come out in a steady stream. Since the type of flow depends not only on the intraspinal pressure but also on the bore and patency of the needle, it is obvious that estimation of the intraspinal pressure by counting the number of drops per minute or from the velocity of flow is subject to many errors.

The normal cerebrospinal fluid is a clear, colorless, slightly alkaline liquid which does not coagulate spontaneously. Its specific gravity is 1.006 to 1.008. It contains sodium chloride (720 to 750 mg. per cent), a trace of albumin (25 to 50 mg. per cent), urea (20 to 50 mg. per cent), and glucose (50 to 60 mg. per cent). Normal cerebrospinal fluid contains few or no cells.

A complete study of the cerebrospinal fluid includes examination of its physical properties, chemical composition and bacterial content, determination of the number and character of cells present and performance of certain serologic tests. The clinician should interpret the gross findings and should make a cell count and a stained smear, but further examination should be done by a competent serologist.

If the cerebrospinal fluid is clear, it does not follow that it is normal, as the fluid may be clear in syphilis, epidemic encephalitis and early tuberculous meningitis. Generally, however, abnormal fluid presents changes varying from a slight cloudiness to

actual purulency or shows flocculation. The faintest discoloration or the least turbidity in spinal fluid is significant. To detect such changes the fluid may be compared by daylight with tap water in a similar test tube.

Gross blood in the spinal fluid may be due to (1) trauma to the meninges during puncture or to accidental puncture of a vein, or (2) hemorrhage into the cerebrospinal fluid from disease of or trauma to the meninges of the brain, spinal cord or cerebral ventricles. Fresh blood from trauma incident to puncture is generally not well mixed with the fluid and when the specimen is centrifuged the supernatant fluid is fairly clear. Blood from higher up in the system generally is well mixed. Xanthochromia may be the only evidence of an old hemorrhage. Blood interferes with chemical and cytologic examination. If the blood is incident to puncture and the fluid does not come clear after a few drops, a puncture should be done in a higher interspace or the procedure should be repeated in a few days.

Xanthochromia does not necessarily indicate hemorrhage. A yellow colored fluid is often found below the level of compression of the cord produced by tumors, tuberculosis, syphilis or bone disease. There are two syndromes described that are significant of cord compression. The syndrome of Froin is the presence of xanthochromic spinal fluid that clots spontaneously but has a normal cell count. The syndrome of Nonne is the presence of spinal fluid with an increase of protein but an absence of pleocytosis.

Cytologic study is an important part of examination of the cerebrospinal fluid. Cell counts are done with a counting chamber, as in the method used for blood count determinations. In syphilis, tuberculosis, epidemic encephalitis and late in acute anterior poliomyelitis there is a pleocytosis with predominance of lymphocytes. In meningococcal meningitis and other meningitides due to pyogenic organisms, pleocytosis is present with a predominance of polymorphonuclear leucocytes. The total number of cells is an index to the severity

of the meningeal reaction. Tumor cells may be found in the sediment of the spinal fluid in the presence of a malignant neoplasm of the meninges.

Any sediment should be stained with methylene blue and studied for the presence of organisms. Culture or guinea pig inoculation should be done by a competent pathologist.

Chemical analyses may be helpful in diagnostic problems. An increase in the protein content of the cerebrospinal fluid indicates meningitis. Glucose concentration is diminished or absent in tuberculosis and pyogenic meningitis. Glucose concentration is increased in epidemic encephalitis. Urea is increased in uremia. These examinations, as well as the Wassermann reaction, colloidal gold test and mastic test, are procedures best done in a well equipped laboratory.

Aside from the pressure and fluid studies mentioned above, spinal puncture is used for two other important diagnostic procedures: (1) The injection of air into the lumbar canal as a contrast medium in roentgenographic study of the cerebrospinal system. This procedure was introduced by Dandy<sup>6</sup> in 1919 for the study of tumors of the nervous system. He considers it dangerous in the presence of brain tumors and prefers the injection of air directly into the ventricles for such studies (ventriculography). (2) The injection of radiopaque solutions into the subarachnoid space for roentgenographic studies of the central nervous system. Iodized oils and thorotrast have been used, but thorotrast has been generally discontinued because it was found unsafe. Iodized oils should be used with caution as they, too, are irritants, are not absorbed and cannot be removed entirely from the subarachnoid space.

#### THERAPEUTIC SPINAL PUNCTURE

Spinal puncture is frequently used for therapeutic purposes, some of which are listed below:

1. Production of spinal anesthesia.

2. Relief of increased intracranial pressure in:

- (a) Head injuries
- (b) Coma due to sunstroke
- (c) Electric shock
- (d) Uremia with convulsions
- (e) Delirium tremens due to alcoholism
- (f) Hydrocephalus

3. Introduction of antimeningococcus serum in epidemic meningitis.

4. Introduction of antitetanic serum.

5. Introduction of salvarsanized serum.

6. Introduction of magnesium sulfate in tetanus.

#### CONTRAINDICATIONS

Spinal puncture is dangerous in the presence of a marked increase of intracranial pressure, as sudden release may cause compression of the medulla. If the history or physical examination suggests increase in intracranial pressure, or if the optic discs are choked, it is safer not to do a spinal puncture. If one is necessary, extreme caution should be exercised and only a small quantity of fluid should be removed from the spinal canal. Posterior fossa tumors are considered more dangerous than supratentorial tumors, as the cerebellum may herniate into the foramen magnum and compress the medulla.

#### COMPLICATIONS

Although death directly attributable to spinal puncture is infrequent, as is evident in the report of Wieder<sup>7</sup> of one death in thirteen thousand patients subjected to spinal puncture, the procedure should never be taken too lightly. Sudden release of a markedly increased intracranial pressure may force the medulla into the foramen magnum and cause instant death.

The most frequent but usually least serious complication is the postpuncture headache. This has been considered a "hypotensive" headache and is believed to be due to leakage of fluid through the rent in the arachnoid and the dura. It can be guarded against by using the smallest needle

possible with a short tapered point (Pitkin).<sup>8</sup> Nelson<sup>9</sup> suggested that to prevent leakage a piece of sterile catgut be introduced through the needle and left in place to plug the hole, but this has not been generally adopted. The following discussion of J. E. Moore and his associates<sup>10</sup> covers the more important points in the management of spinal puncture headaches:

"Puncture headache may be prevented in practically every patient by performing the puncture with the patient in the recumbent position in bed, and by keeping him flat in bed in a horizontal position for 48 hours afterward. This necessitates the use of a bedpan and of someone to assist the patient at mealtimes. He should be warned against sitting up.

"If the puncture is done in the office or clinic the patient should be sent home to bed at once, with instructions to remain there, as above advised, for 48 hours. Under these conditions a few patients will develop headaches even when a needle of very small caliber is used. Puncture headache is characterized by its great severity while the patient is in the erect posture, and by its prompt and usually complete disappearance as soon as he lies down. It is sometimes, though infrequently, associated with nausea and vomiting. If a headache occurs, the patient should be reassured, sent to bed for an additional 3 or 4 days, and instructed to drink a great deal of water. The headache is difficult to control with drugs if the patient insists on being up. It commonly lasts 3 or 4 days, but may persist for 2 weeks. It is not serious."

Pease<sup>11</sup> called attention to the possibility of introducing the needle too far and injuring the intervertebral disc. Milward and Grout<sup>12</sup> reported five instances of damage to an intervertebral joint following lumbar puncture.

In the presence of a cord tumor, spinal puncture may be followed by sudden and marked increase of symptoms. This is an important diagnostic point. The segmental level may also become more definite.

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# USE OF LOCAL ANESTHESIA IN MINOR LACERATIONS

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THE first duty of a surgeon called to treat a patient with a minor laceration is to determine the extent of the injury. This decided upon he is responsible for treating that wound in a way which will first safeguard the life of the patient, second, give the best functional result possible, and third, be carried out with a minimal amount of suffering to the patient. It is with this last in mind that the present paper has been prepared.

The present series of private patients was begun in 1934, with emphasis on the fact that the procedure was utilized in minor lacerations only, namely, those in which the skin and subcutaneous tissue had been divided, and an occasional instance where a muscle or superficial tendon had been severed. It was not used in those wounds grossly soiled and embedded with dirt.

## PROCEDURE

After determining the nature and extent of the injury, any hair about the wound was removed by shaving. The skin of the surrounding area was then cleaned with green soap and water, care being taken not to permit the soap to enter the raw laceration. The wound was flushed with sterile physiologic saline. The surgeon scrubbed his own hands and forearms in the usual manner for about five minutes, completing this by immersing them in alcohol for one minute. In the past three years sterile rubber gloves have been worn, while in the first two years they were not considered necessary (no difference in results has been noted). Inasmuch as all of these patients were treated in an accident room where ungowned or unmasked attendants are constantly entering, no gown or mask was worn.

The area about the wound was prepared by applying some antiseptic. In the earlier

cases Scott's solution was used. It, however, had the disadvantage of causing pain if it entered the raw area. In subsequent cases kalmeride was employed but was found to have the same disagreeable effect. This was discarded in favor of 2 per cent aqueous solution of mercurochrome which could be placed in the laceration itself without discomfort; this in turn, because of its red stain, has been succeeded by 1:1000 aqueous solution of merthiolate which is colorless and can be applied to the raw surface as well as the surrounding intact skin without discomfort. No difference between these antiseptics was noted as far as concerned the healing of the wound or the prevention of infection.

The area was then draped with sterile towels in the usual manner. The wound was inspected carefully for foreign bodies which, if present, were removed, along with any blood clots which remained.

The local anesthetic was then applied in the following manner: 1 per cent procaine hydrochloride was injected subcutaneously by means of a 2 or 5 cc. Luer syringe fitted with a small hypodermic needle. The needle point was inserted just beneath the cut edge of the skin (Fig. 1) entering through the raw surface and the subcutaneous tissue infiltrated. The insertion of the needle in this fashion caused apparently no pain and the injection of the fluid was followed by immediate anesthesia. The entire circumference of the wound was infiltrated in this manner. If the wound edges were badly contused so as to appear doubtfully viable or were soiled by some substance difficult to remove, as grease, they were painlessly excised with a sharp knife. The sutures could then be placed at leisure with no pain or discomfort to the patient and without destroying the confidence of very young children.

Lacerations of the face, neck, shoulders or other visible areas were repaired with horsehair, using an end-on mattress suture popularized in this locality by Dr. J. S. Davis.<sup>5</sup> The scalp and perineum were stitched with silk by means of the usual Lembert suture. In a few instances buried ligatures or sutures were necessary and they were of plain No. 0 catgut. In some wounds with marked overhanging of large flaps and large dead spaces a drain was inserted and removed at the end of forty-eight hours. Stitches were removed from the face in four to five days from the scalp and from the back in six to seven days. Where the laceration extended across a joint, as the interphalangeal joint of a finger, that joint was immobilized with a splint.

In previous years the dressing usually consisted of dry gauze, recently, however, xeroform gauze was applied immediately over the wound with dry gauze superimposed upon it. This is believed to be of value, particularly in hot weather, inasmuch as the greasy ointment serves as a protection to the wound against outside contamination from perspiration, while it is not a rigid enough seal to retain pus under pressure should infection occur. Wounds of the lip, nostril and canthus of the eye, where a dressing is difficult to apply and contaminating secretions are present, were dressed by the direct application of compound tincture of benzoin evaporated to a sticky consistency. When exposed to the air this dried quite rapidly, forming a waterproof seal to the suture line. It was easily removed when the time arrived for a change of dressing by applying vaseline to the area twenty-four hours before the appointment and on arrival the benzoin had changed from a hard to a soft consistency and could be picked off with forceps without difficulty.

#### DISADVANTAGES

The most serious objection is a theoretical one, namely, that the needle is entering uncontaminated tissue through a poten-

tially contaminated field and in this manner might carry some bacteria upon its surface which would be disseminated by the in-

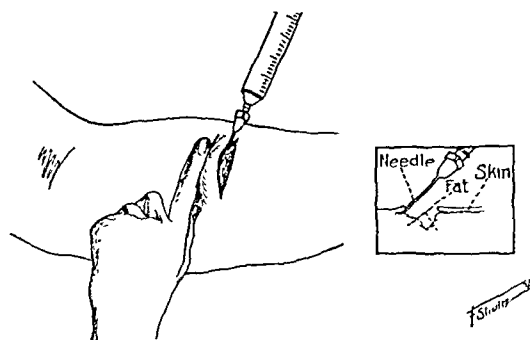


FIG. 1. Diagram illustrating the insertion of the needle point through the cut edge and just beneath the skin into the subcutaneous tissue.

filtration. The theory presented is reasonable but no supporting evidence, clinical or experimental, could be found either in the literature or by word of mouth.

The second objection is likewise theoretical, namely, that the use of infiltrative anesthesia retards the healing of wounds due to the presence of ischemia and the increased liability to infection. No clinical or experimental support of this was found and indeed Gwathmey<sup>4</sup> states that "healing is in no way hindered" by local anesthesia.

Griswold,<sup>1</sup> in 1938, states that if local anesthesia is utilized in fresh wounds it should be injected through the surface of the intact skin, but gives no reasons or supporting evidence.

Christopher<sup>2</sup> states that the use of local anesthesia in open wounds should be more generally employed and that its omission is generally due either to the unpreparedness or the laziness of the physician. He advises injecting the anesthetic into the skin at the margins of the wound but the illustration shows the needle penetrating the unbroken skin surface.

Hertzler<sup>3</sup> states that "usually in emergency work a linear injury to the soft parts is sutured without formality. The sensibilities of the patient, however, can be spared by infiltrating endermically an elliptical line about the wound with novocaine."



The other authorities on surgery, minor surgery, traumatic surgery and anesthesia, who were consulted, did not mention the use of local anesthesia for minor lacerations.

### RESULTS

This method was used in 255 cases involving 372 separate lacerations in various parts of the body. Seventeen of these pa-

TABLE I

Location	No. of Cases	Infections	No Follow-up
Forehead	71	0	3
Scalp	48	0	1
Fingers	39	4	2
Lip	24	1	3
Chin	23	0	0
Leg	22	1	2
Face	21	0	0
Hand	18	0	2
Nose	17	0	0
Forearm	16	0	2
Eyelid	16	0	0
Elbow	11	0	0
Knee	10	1	0
Ear	7	0	1
Upper arm	7	0	0
Thigh	6	0	0
Perineum	5	0	0
Back	4	0	1
Foot	2	0	0
Toe	1	0	0
Buttock	1	0	0
Penis	1	0	0
Axilla	1	0	0
Abdomen	1	0	0
Total	372	7	17

tients did not return for the removal of sutures or other follow-up and, therefore, were discarded. Of the remaining 238 patients with 355 wounds, all healed without infection except seven, an incidence of 1.9 per cent. Of the clean cases, 321 patients were discharged well within one week, ten at the end of ten days and three after two weeks. The exact time of healing of the remaining sixteen is not mentioned due to the fact that there were other injuries upon which more emphasis was placed.

In five cases there were sloughs due to a questionable blood supply to the flaps at

the time of suturing. These five patients were under treatment for six weeks, eighteen days, three weeks, two weeks and two and one-half weeks, respectively. Any case with even the most superficial and minor infection was classified as such.

TABLE II

Ages in Years	No. of Cases
0-5 (youngest 17 months)	14
5-10	28
10-20	40
20-30	56
30-40	45
40-50	21
50-60	16
60-70	10
70-80 (oldest 77 years)	4
Not known	21
Total	255

Of the seven infected patients four infections occurred in wounds of the fingers when the patients, against advice, continued manual labor under dirty circumstances, soiling the dressings and immersing their hands in water. One of these developed a thenar abscess which subsequently had to be opened, thus prolonging treatment for four weeks. In another, removal of the sutures provided adequate drainage and he was discharged in two weeks. One laceration of the knee became infected and required four weeks for healing, while another laceration of the lower leg likewise infected required three and one-half weeks of treatment. The seventh, a lacerated lip, healed promptly in one week. In no case was the infection severe enough to endanger the life of the patient or to require hospitalization for its treatment. The anatomic distribution of the injuries is tabulated in Table I.

No difference was noted in the appearance of the scar as compared to those cases in which other injuries made a general anesthetic necessary for their treatment as well as the suturing of the wound.

### ADVANTAGES OF THE PROCEDURE

The prime advantage of this method of treating minor lacerations is that it renders the treatment painless. This is believed to

be a valuable asset and indirectly may cause even further benefits. Thus sutures could be placed leisurely and exactly as desired without being malplaced due to the wincing of an adult or the struggles of a child. Furthermore, the wound could be more carefully inspected for the presence of

painful procedure. The oldest patient was 77.

Furthermore, the method is simple, requires no special apparatus or assistance and is applicable to office as well as hospital practice.

#### COMMENT

The writer hesitated before presenting such a minor subject and had some qualms about advocating a procedure which has had the disapproval of at least some authorities. Furthermore, he is well aware of the theoretical soundness of the objections voiced. With no objective evidence against the procedure, while actual experience in 355 wounds has given what is believed to be a satisfactory result, it is the author's conviction that the practical advantages have outweighed the theoretical danger. However, it should be utilized only in selected cases, eliminating the grossly dirty, badly contused wounds and restricting its use to those lacerations which are linear in type and relatively clean.

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TABLE III	
Cause of Injury	No. of Cases
Automobile	117
Bumping against unseen object	29
Fall	24
Glass or tin	24
Sharp instrument	18
Athletics	18
Machinery	10
Struck by stone	4
Fight	3
Kicked by horse	2
Dog bite	2
Epilepsy	1
Not known	3
Total	255

foreign bodies, unhindered by the above movements. Again, many children, whose confidence in the surgeon was not shattered by a painful procedure, permitted the repair of their wounds in this fashion; whereas a general anesthetic with its greater risk as well as expense would have been necessary. This is illustrated in Table II which shows that fourteen of the above patients were less than 5 years of age, the youngest being 17 months, while an additional twenty-eight were between 5 and 10, ages wherein cooperation would often be impossible for a



# PARALDEHYDE: A BASAL ANESTHETIC FOR TONSILLECTOMY IN CHILDREN

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THE importance of preoperative sedation is almost universally accepted.

There is, however, no unanimity as to drug or dosage. Paraldehyde by rectal instillation has been used for this purpose for many years, almost all of the published literature emanating from abroad. Reports from Great Britain and her colonies have been most enthusiastic. Claims have been made that this method of sedation is (a) safe for both children and adults; (b) rapid and certain in action; (c) safe for use in "bad risk" patients, such as decompensated cardiacs, cachectics, and chronic nephritics; (d) offering complete amnesia with a refreshing sleep.<sup>1-10</sup>

In addition, the statement is repeatedly made that there is no effect upon either circulatory or respiratory system, almost all of the drug being eliminated unchanged through the lungs, the remainder through the kidneys.

Impressed with the valuable properties ascribed to paraldehyde by rectum, and especially the favorable report of Sourasky<sup>11</sup> on its use as a preliminary to tonsillectomy in children, we have been giving paraldehyde by rectum routinely since 1937 as a premedication for tonsillectomy to all children on Otolaryngological Ward Service Number Three at the Jewish Hospital. The following technique has been used.

The patient is given a simple enema the morning of operation. One hour preoperatively he receives a retention enema of paraldehyde. In the first series of 104 consecutive cases, this was used in the proportion of 1 c.c. for every 5 pounds of body weight. In the second series of 117 consecutive cases, the ratio was changed to 1:8. In several unselected cases this was fur-

ther reduced to 1:10. The largest dose ever used was 20 c.c. in a 12 year old child.

The paraldehyde is usually mixed by simple agitation with an equal volume of tap water and given with a soft rubber catheter and syringe at room temperature. Occasionally mineral oil is substituted for the water. The enema is easily retained by all but the youngest children who sometimes do not cooperate. Within fifteen minutes, patients fall into a sound sleep that resembles normal slumber. Although they can be aroused, they are somewhat confused and fall off to sleep again. Preoperative restlessness and excitement are not observed nor are there any other untoward symptoms.

All the children in our series took anesthesia well (invariably open drop ether). After the operation, they continued to sleep for four or five hours, a slumber that was peaceful and much longer than that usually seen. If vomiting occurred, they awoke for a short spell and then promptly returned to sleep. Drowsiness was observed for about twelve hours. There was no hang-over, proctitis, or other unpleasant sequela. The pharyngeal reflexes were not interfered with during operation.

As a control, the records of a number of routine tonsillectomies performed on the same service just prior to 1937 without benefit of any premedication were reviewed. Postoperative vomiting in the paraldehyde group was diminished both in extent and in the number of patients affected, occurring in 43.3 per cent of patients receiving paraldehyde in the 1:5 ratio, 50.4 per cent of those receiving it in the 1:8 ratio and 63.3 per cent of the controls.

Postoperative resuturing for profuse bleeding was required in two of the paraldehyde and two of the control series. In all four instances, the additional suturing was required about five to twelve hours after the operation. There was nothing to sug-

TABLE I  
NUMBER OF CASES BY AGES

Dose	Age												Total
	2	3	4	5	6	7	8	9	10	11	12		
1:5	11	8	11	10	22	12	10	8	4	4	4	104	
1:8	6	12	18	16	24	10	13	6	3	7	2	117	
1:10					1	1	1					3	
Total	17	20	29	26	47	23	24	14	7	11	6	224	
Controls	29	57	46	54	52	44	29	23	22	12	16	384	

gest more bleeding or capillary oozing in those patients under paraldehyde narcosis.

The nursing staff did not find the administration of the sedation an involved procedure. On the contrary, they were most enthusiastic because of the smooth postoperative convalescence. The higher

TABLE II  
NUMBER OF CASES OF POSTOPERATIVE VOMITING

	Age												Total	Per-centage
	2	3	4	5	6	7	8	9	10	11	12			
Paraldehyde cases	7	8	18	15	21	11	14	5	3	5	0	107	47.8	
Controls.	11	35	28	32	41	33	16	14	16	9	8	243	63.3	

dosage was considered more effective and more satisfactory. The unpleasant odor of paraldehyde was not a factor of any importance in this study in that it was not perceptible to anyone postoperatively and was never even noticed by the patient. On questioning, many of the older children acknowledged complete amnesia of recent events, some of them asking when the tonsillectomy was going to be performed.

The wide margin of safety present with paraldehyde is illustrated by the following case report presented here through the courtesy of the attending surgeon.\*

R. Z., a white male child, 9 years old, was admitted to the Jewish Hospital with a diagnosis of acute appendicitis. His temperature, pulse and respirations were 100°F., 110 and 22 respectively. He was to have received 2 drachms of paraldehyde mixed with 1 ounce of water as a retention enema, but was inadvertently given

TABLE III

Paraldehyde Dose	No. of Cases	Average Pulse Rate		Postoperative	
		Before Operation	After Operation	Abdominal Pain	Ear-ache
1:5	104	102.4	113.7		
1:8	117	100.8	108.6		
1:10	3				
Total Controls	224 384	..... 101.5	..... 111.0	2 3	0 4

2 ounces of paraldehyde. Within fifteen minutes, the patient lapsed into unconsciousness with shallow breathing, pin-point pupils and some cyanosis. The error in dosage was noted immediately and a mixture of oxygen-carbon dioxide administered. One-half hour later, the patient's condition being considered good, operation was performed without additional anesthesia and a gangrenous appendix removed without drainage. At this time, the pulse reached a high of 160 per minute with a respiratory rate of 44 per minute. The temperature rose to 101°F. (All temperatures are rectal.) A continuous intravenous infusion of 10 per cent glucose in normal salt solution was begun although there were no alarming signs. Gradual return of consciousness began, followed by complete recovery about twelve hours after the administration of the drug. Convalescence thereafter was entirely uneventful. Urinalyses were entirely negative throughout.

Hanson<sup>12</sup> described a case in which 4 ounces of paraldehyde were given by rec-

\* From the surgical service of Dr. N. Rothschild.

tum in a single dose to a woman in labor instead of the desired  $\frac{1}{4}$  drachms. The patient made a complete recovery and renal activity was at no time affected.

Walker<sup>13</sup> had a similar experience, the dose given being 2 ounces each of paraldehyde and ether. There were no sequelae.

The entire subject of paraldehyde poisoning has been reviewed by Kotz, Roth and Ryon,<sup>14</sup> who concluded that paraldehyde is a relatively safe and effective analgesic agent and that fatal poisoning with it is rare despite frequent overdosage.

#### SUMMARY

Paraldehyde was used as a preoperative sedative for tonsillectomy in children in 224 cases. Best results were obtained using 1 c.c. of paraldehyde for every 5 pounds of body weight, mixed with an equal volume of tap water as a retention enema. The results were highly gratifying, the method simple and safe, the cost insignificant. No untoward reactions were observed.

A case of accidental administration of 60 c.c. of paraldehyde by rectum to a 9 year

old child, with uneventful recovery, is reported.

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# INFECTIONS OF THE TENDON SHEATHS

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**I**NFECTIONOUS tenosynovitis is best illustrated in the hand and forearm for we find these sites most frequently involved. This type of infection is always a serious one and may result in complete loss of function of the involved digit together with considerable stiffening of the hand. While the offending organisms are usually the streptococcus or staphylococcus, other organisms may affect the tendon sheaths.

From a clinical point of view the sheaths upon the flexor surface of the hand are the most important. Figure 1 illustrates the location of the various sheaths and the incisions necessary to give adequate drainage. On the dorsum of the hand the sheaths are less extensive but the infection here can also rupture into the adjacent fascial spaces of the palm.

With the organisms of streptococcus and staphylococcus the infection is commonly an acute one and the viability of the tendon is always threatened if the patient is not treated promptly.

A puncture wound in the pulp of the finger may cause a local infection and easily extend across the thin membrane constituting the terminus of the flexor tendon sheath. The streptococcic infection may spread up into the finger or hand in only a few hours; and while the staphylococcus spreads more slowly, local distention of the tissues with exquisite pain and tenderness is the rule. Kanavel has shown conclusively the pathway these infections of the hand follow. He has stressed that one must be familiar with the essential anatomy of the hand to appreciate and prevent dangerous complications from infections of the tendon sheath.

Following involvement of the tendon, there may be separation with the final death and destruction of the tendon.

Usually the patient will remember the entrance of some foreign body into the hand or a puncture of the finger, and all of these penetrating wounds are particularly dangerous if located over the flexor creases of the fingers or thumb. At this point the sheath lies close to the skin, and is not protected by the pad of fat found over the shaft of the phalanx. Infection may also start by direct extension of a nearby infection and the finger will quickly assume the semiflexed attitude. Exquisite tenderness will be found along the sheath throughout its entire course. Immediate operation should be done to relieve the tension before there is necrosis of the tendon; and if the infection lies within the tendon sheath itself, it must be quickly opened and every effort made to give adequate drainage. Incisions, therefore, must be made as outlined, placing them on the side of the finger toward the dorsum and not on the flexor surface. The incision by being placed on the side will prevent any tendency to bowing of the underlying tendon and the resultant scar will give a minimum of functional disability. The vessels and nerves will be avoided by placing the incision toward the dorsum of the finger as shown in the diagram and adequate drainage of the sheath will be provided. Care should be taken to retain bridges of the tendon sheath opposite each joint as shown by the diagram and the skin wound should be loosely packed—not the tendon sheath. Care should also be taken not to lift or disturb the tendon sheath from its bed. Following this emergency surgery, a 1/1000 solution of acroflavine and glycerin or sterile paraffin oil may be used to prevent the packing from adhering to the surrounding tissues and yet permit free drainage. This dressing can

be easily changed with a minimum amount of discomfort to the patient, but it need not be changed more than once a day. If

When the dorsal synovial sheaths are infected, splitting of the sheath throughout its course apparently gives the best results,

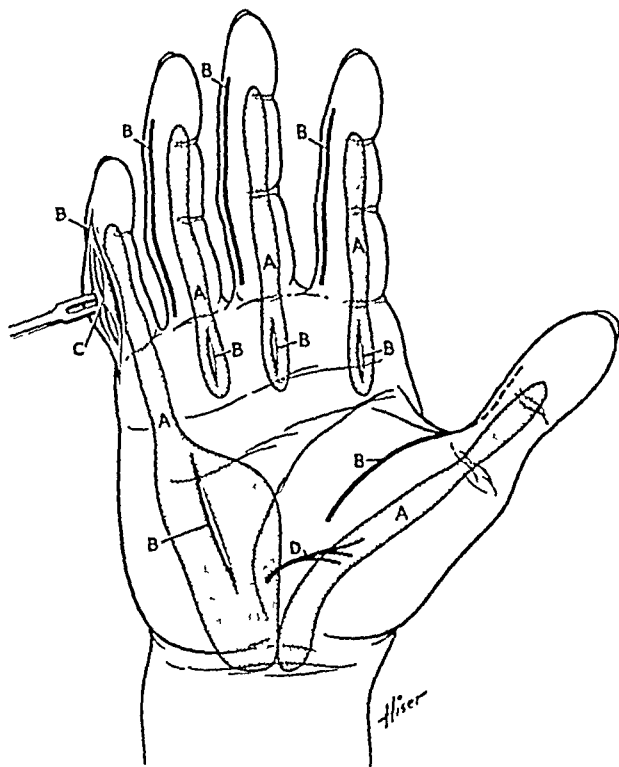


FIG. 1. A, anatomic distribution of flexor tendon sheaths. B, elective skin incisions for draining tendon sheath infections. On fingers incisions should be posteromedial or posterolateral. C, illustrating how island of tendon sheath should be preserved at flexion creases. D, incisions should not be prolonged to injure branches of ulna nerve.

this technic is employed, hot compresses and hot sand bags can be discontinued except for the first few days of the inflammatory reaction. It is well to splint the fingers but to allow motion early, so the time of splinting can be cut as short as possible. Couch advises that the hand be laid on a pillow with the palm upward or carried in a sling as it will fall into a much better functional position than if it is permitted to rest palm downward. This latter position may give rise to a rather useless type of "flat hand." Active movement of these infected hands should be started as soon as the patient comes out of the anesthetic; and if one is dealing with a cooperative patient, later results will repay him for his initial pain and discomfort on forced movement.

but this locality is much less frequently affected than the palmar sheaths and the danger of the fascial spaces being involved is also less.

The treatment pursued in the first few days following the incision and drainage is very important. It is a good plan to immerse the patient's hand and forearm in hot sterile water while the surgeon gently and passively moves and extends the fingers and wrist several times each day. This early, gentle manipulation will encourage the patient to move the involved tendon sheaths.

Sulfanilamide is routinely used in all the streptococcic, staphylococcic and gonococcic infections involving tendon sheaths.

Gonococcic tenosynovitis can be established by the history of a recent urethritis

and finding of the organism on smear. It is not as common a complication of gonorrhea as a transient multiple arthritis, but when found is best treated by local rest to the part and chemotherapy.

Syphilis involving the tendon sheaths is occasionally seen but is not a rapidly fulminating process, although it may be a manifestation of the disease in its early stage. It yields most satisfactorily to anti-luetic treatment.

Another form of sheath infection is caused by the tubercle bacillus. It is most commonly found involving the flexors and extensors of the wrist, but it may be found in the tendon sheaths about the ankle. It is characterized by a leathery crepitation which can be felt and sometimes heard if the tendons actively move. It is a chronic process and on opening the sheaths a varying number of "rice bodies" may fall out

of the wound. Treatment consists in evacuating these "rice bodies" and in making as complete an excision of all the infected tissue as possible. Excision of the tendon sheaths in these cases is tedious but offers the best chance of cure. A more conservative method advised may consist in introducing 5 per cent iodoform in glycerin into the tendon sheaths followed by a long period of immobilization.

#### SUMMARY

Acute infections of the tendon sheaths most frequently involve the fingers and hand, and due to the anatomic arrangement of these sheaths rapid spread of the infection may be expected.

Early adequate surgery along the areas of election shown in the diagram offer the best opportunity for the return of function.





# INFECTION OF FASCIAL SPACES OF THE PALM\*

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THERE are two constant, well defined fascial spaces in the palm. These spaces lie deep to the flexor tendons and their sheaths and to the digital nerves and vessels. It is important that the surgeon who makes incisions for drainage of infection in this region have a knowledge of the anatomy of the hand.

The middle palmar space lies between the flexor tendons and lumbricales anteriorly and the fascia covering the interosseus muscles behind. Medially the space is limited by the attachment of the palmar fascia to the fifth metacarpal. The thenar space lies chiefly between the palmar fascia in front and the adductor pollicis behind. The flexor tendons and lumbrical muscle of the index finger are anterior to the medial portion of the thenar space. Laterally the space is limited by the radial bursa. These two spaces are separated from each other by a fibrous septum extending from the palmar fascia backward to the third metacarpal. They extend distally to a line drawn from the ulnar end of the distal flexion crease of the palm to the radial end of the proximal flexion crease. Proximally they extend to about an inch below the distal flexion crease of the wrist. These spaces send projections along each finger to enclose the lumbrical muscles and the digital nerves and vessels. The lumbrical canal of the index finger enters the thenar space. The canals from the three medial fingers enter the middle palmar space. (Fig. 1.)

Fascial space abscesses occur after local implantation of pyogenic organisms. The injury responsible for the development of a hand infection may be anything from an apparently trivial prick with a pin or

splinter to an extensive laceration or contusion. The organism is usually a *Streptococcus* or *Staphylococcus aureus*.

Infections of the fascial spaces of the palm are more often secondary to other infection in the hand than primary from direct injury. Infection may enter by extension down the lumbrical canals either from subcutaneous infection in a finger or after rupture of an infected flexor tendon sheath at its proximal end. Either the radial or the ulnar bursa may rupture into the adjacent fascial space. Infection in the middle palmar space is usually from the middle, ring or little finger. Infection in the thenar space comes from the thumb or the index finger.

The symptoms of palmar space abscesses are those of a severe local inflammation plus a general toxemia. Suppuration in either the middle palmar or the thenar space results in a swelling of the entire hand. The swelling over the back of the hand is usually great, but it is a pitting edema rather than the brawny induration seen on the palmar surface. The fingers and thumb are held in flexion but they can be moved passively with only moderate pain. There is no well localized tenderness and no fluctuation even though the amount of pus present is considerable.

In a middle palmar space infection there is usually a bulging in place of a concavity in the palm. In other types of hand infections the concavity of the palm is often lost but it does not become a convexity. There is tenderness over the entire palm, particularly over the ulnar side. There is pain on moving the third, fourth and fifth fingers. There may be extension of the infection along the lumbrical canals of these three fingers. This causes pain, tenderness,

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redness and swelling in the webs between the fingers. Pointing or fluctuation may be present here. The infection sometimes ex-

Infection beginning on the thumb may reach the thenar space if it is confined to the subcutaneous tissues. Involvement of

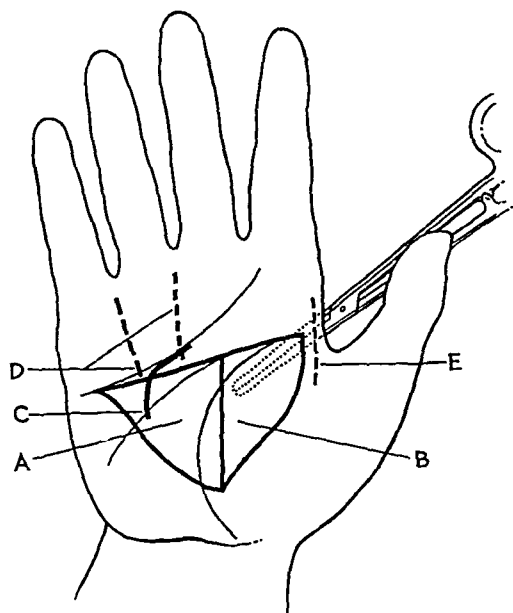


FIG. 1. A, middle palmar space; B, thenar space; C, incision for drainage of middle palmar space; D, incisions for drainage of middle palmar space with extension into the lumbrical canals; E, incision on the back of the hand for drainage of the thenar space.



FIG. 2. Incision for draining thenar space.

tends between the heads of the metacarpals and points on the dorsum of the web.

A thenar space abscess results in an extreme amount of swelling of the thenar eminence. The swelling of the back of the hand is more marked on the radial side. Movements of the thumb and index finger are limited and more painful than movements of the other fingers. The abscess sometimes points in the web between the thumb and index finger.

Involvement of both spaces is more difficult to diagnose. The extreme swelling of the entire hand, the large thenar eminence and the bulging in the palm are the most characteristic findings.

In attempting to make a diagnosis of a possible fascial space abscess the first point to be determined is the site of the original injury. This should be followed by an accurate history of the subsequent course of the infection.

the tendon sheath of the flexor pollicis longus will spread the infection through the radial bursa. From here it is more apt to extend to the ulnar bursa and to the forearm than it is to the thenar space.

Infection extending upward from the index finger may reach the thenar space. This is particularly true if the flexor tendon sheath becomes infected and ruptures at its proximal end. Infection following injury to the tissues of the thenar eminence may reach the thenar space as the palmar fascia is thin over its lateral portion and forms a poor protective barrier.

Infection from the middle and ring fingers, whether or not it involves the tendon sheaths, may reach the middle palmar space. This is also true of subcutaneous infection of the little finger. Infection in the tendon sheath of the little finger will continue along the ulnar bursa and reach the forearm and the radial bursa before involving the fascial spaces of the palm.

Infection implanted directly into the concavity of the palm will not spread through the palmar fascia. If it is placed under the aponeurosis, the infection will extend to the fascial spaces.

Abscesses of the middle palmar and thenar spaces do not extend upward to the forearm. They may point in the webs between the fingers and rupture on the back of this region or they may extend into the radial or ulnar bursas. Evidence of infection above the wrist joint in the presence of fascial space abscesses indicates such an extension to the bursas.

The prognosis of uncomplicated fascial space abscesses promptly recognized and properly treated should be excellent when compared to the end results of hand infections involving tendon sheaths.

#### TREATMENT

The treatment of infection of the fascial spaces of the palm is incision and drainage as soon as a diagnosis of suppuration in this region can be made. To wait for such an abscess to point or to wait for fluctuation to occur may do irreparable damage by allowing the infection to spread to other structures. To wait until the day after a decision to operate has been made is negligence.

The patient should be in a hospital in order not only to insure a proper operation but also to supervise the postoperative care. A general anesthetic is necessary. The arm is held vertical for at least three minutes to drain the blood from it, then a tourniquet is applied. This may be a blood pressure cuff or a wide rubber band.

The operator should have in mind before he begins just what anatomic structures he intends to expose. He should then proceed with a careful dissection to expose those structures. Skin incisions should be placed in such a manner that they allow adequate drainage, do not endanger important underlying structures and do not result in disabling contractures on healing. The wound edges and the underlying nerves, vessels and tendons or tendon sheaths

should be retracted as the operation proceeds to allow a good view of the bottom of the wound at all times. There is no place in the surgery of hand infections for the quick, stabbing incision. If pus enters the wound, it should not be considered a signal that the operation is finished. The pus should be wiped out and the operator should continue until he is certain that all abscess cavities are opened adequately.

The middle palmar space can best be opened by an incision which begins in the interval between the metacarpals of the middle and ring fingers at the distal flexion crease of the palm or just proximal to the crease. From here the incision runs parallel to this crease across the metacarpal of the ring finger, then curves upward and runs parallel to and just in front of the ulnar border of this metacarpal as far as the proximal flexion crease. The flexor tendons of the ring finger will be exposed and are to be retracted laterally. The digital vessels and nerve to the ulnar side of the ring finger will be exposed and should be retracted medially. The middle palmar space can then be opened through an incision similar to the skin incision. The ulnar bursa extends as far distally as the proximal flexion crease, therefore, care must be used to avoid injuring the ulnar bursa in the upper end of the wound. This incision allows good drainage of the middle palmar space, does not injure nerves or vessels and does not cross flexion creases with a resultant contracture of the scar. The incision can be extended proximally to open the ulnar bursa when this is also infected.

If the infection extends down along the lumbrical canals, a better incision is one made directly over the infected spaces in the web between the fingers. This extends proximally to just above the distal flexion crease. From here a hemostat can be thrust into the middle palmar space. The incision must not extend across the edge of the web. In this incision as in the one previously described the digital nerve and vessels must be identified and retracted to avoid injuring them. This incision has the disad-

vantage of not giving as good exposure as the other and also it crosses a flexion crease at a right angle with a resultant danger of contracture developing.

Thenar space abscess is drained through the back of the web between the thumb and index finger. (Fig. 2.) With the thumb in a position of opposition the incision is made along the anterior edge of the distal half of the metacarpal of the index finger. A hemostat is inserted into the thenar space and opened widely. The hemostat must not be inserted past the lateral border of the third metacarpal to avoid injuring the fibrous septum between the thenar and middle palmar spaces. In thenar space abscess pus will sometimes lie posterior to the adductor pollicis as well as in the usual position anterior to this muscle. Both locations can be reached through this incision on the back of the web.

When both the thenar and middle palmar spaces are infected, the intervening fibrous septum can be opened by a hemostat thrust through from the lateral side. However, a drain is not inserted through both spaces. There is no place for through-and-through drainage in hand infections.

After the infected fascial space is opened a soft rubber drain is laid into the bottom of the cavity and brought out flat through the wound. A single strip of vaseline gauze can be used in place of the rubber dam. The drains are left in place one or two days. By this time it should be possible to remove them without danger of the wound closing too soon.

A metal splint is incorporated into the bandage after the hand is opened. This will permit proper fixation in the best possible position for function. The metal splint also allows wet dressings to be applied without disturbing the position of the hand. The hand is bandaged with the wrist in moderate extension with slight ulnar deviation;

the fingers are partially flexed and are well separated from each other, and the thumb is in a position of opposition.

Warm wet dressings of normal salt solution are usually applied for twenty four hours or more following surgery. They are then continued for one or more hours daily as long as necessary. The wound is dressed daily using aseptic technic to avoid the introduction of secondary infection. At each dressing the hand is examined for evidence of further spread of infection. At the same time an attempt is made to put all the joints of the hand through a full range of motion. As soon as the infection has subsided and the wound is healing more intensive physical therapy is begun. This consists of hot soaks or whirlpool baths, massage, and active and passive exercises. The hand should be kept in a splint part of the day to preserve the position of function until the wound is entirely healed. It may be necessary to continue active exercises and passive stretching for weeks or months to restore full use of the hand.

The pus is cultured at the time of operation and sulfanilamide or related compounds are administered as indicated. General supportive measures are used as in any severe infection.

#### SUMMARY

1. A knowledge of anatomy is necessary for the proper diagnosis and treatment of infections of the fascial spaces of the palm.
2. Such infections should be considered surgical emergencies and treated promptly.
3. Incisions for drainage of these infections of the hand should be made by careful dissection, with the patient under general anesthesia and with a tourniquet on the arm.
4. The function of the hand after such an infection will depend largely on adequate surgery plus persistent physical therapy.



Infection implanted directly into the concavity of the palm will not spread through the palmar fascia. If it is placed under the aponeurosis, the infection will extend to the fascial spaces.

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Thenar space abscess is drained through the back of the web between the thumb and index finger. (Fig. 2.) With the thumb in a position of opposition the incision is made along the anterior edge of the distal half of the metacarpal of the index finger. A hemostat is inserted into the thenar space and opened widely. The hemostat must not be inserted past the lateral border of the third metacarpal to avoid injuring the fibrous septum between the thenar and middle palmar spaces. In thenar space abscess pus will sometimes lie posterior to the adductor pollicis as well as in the usual position anterior to this muscle. Both locations can be reached through this incision on the back of the web.

When both the thenar and middle palmar spaces are infected, the intervening fibrous septum can be opened by a hemostat thrust through from the lateral side. However, a drain is not inserted through both spaces. There is no place for through-and-through drainage in hand infections.

After the infected fascial space is opened a soft rubber drain is laid into the bottom of the cavity and brought out flat through the wound. A single strip of vaseline gauze can be used in place of the rubber dam. The drains are left in place one or two days. By this time it should be possible to remove them without danger of the wound closing too soon.

A metal splint is incorporated into the bandage after the hand is opened. This will permit proper fixation in the best possible position for function. The metal splint also allows wet dressings to be applied without disturbing the position of the hand. The hand is bandaged with the wrist in moderate extension with slight ulnar deviation;

the fingers are partially flexed and are well separated from each other, and the thumb is in a position of opposition.

Warm wet dressings of normal salt solution are usually applied for twenty four hours or more following surgery. They are then continued for one or more hours daily as long as necessary. The wound is dressed daily using aseptic technic to avoid the introduction of secondary infection. At each dressing the hand is examined for evidence of further spread of infection. At the same time an attempt is made to put all the joints of the hand through a full range of motion. As soon as the infection has subsided and the wound is healing more intensive physical therapy is begun. This consists of hot soaks or whirlpool baths, massage, and active and passive exercises. The hand should be kept in a splint part of the day to preserve the position of function until the wound is entirely healed. It may be necessary to continue active exercises and passive stretching for weeks or months to restore full use of the hand.

The pus is cultured at the time of operation and sulfanilamide or related compounds are administered as indicated. General supportive measures are used as in any severe infection.

#### SUMMARY

1. A knowledge of anatomy is necessary for the proper diagnosis and treatment of infections of the fascial spaces of the palm.
2. Such infections should be considered surgical emergencies and treated promptly.
3. Incisions for drainage of these infections of the hand should be made by careful dissection, with the patient under general anesthesia and with a tourniquet on the arm.
4. The function of the hand after such an infection will depend largely on adequate surgery plus persistent physical therapy.



# LUXATED AND SEVERED TENDONS\*

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**T**ENDON injuries are important because early recognition and proper diagnosis is indispensable to adequate treatment. By luxation or dislocation of a tendon we imply displacement of the tendon from its normal position. By severance of a tendon we mean a partial or complete interruption of continuity. The unsatisfactory results which generally follow failure to diagnose and properly treat these affections justifies a discussion of the principles of diagnosis and treatment.

## LUXATED TENDONS

Displacements or dislocations of tendons is by no means a common finding. The peroneal tendons, however, are more frequently luxated than any other. Either one or both tendons may be involved. A congenitally shallow groove at the external malleolus may be an etiologic factor. In some cases the dislocation may be present at birth, but more frequently it is induced by trauma subsequently.

In a typical case the tendon can be seen and felt to glide forward over the lower end of the fibula as the foot is flexed and slightly everted. Pain is not usually a prominent symptom, the disability being caused by loss of mechanical efficiency of the pull of the tendons. This displacement is often associated with calcaneovalgus deformities of the foot following infantile paralysis.

The type of treatment depends upon whether the case is seen early or late. If the patient is observed soon after the slipping has occurred, the tendons can be replaced. Reduction is maintained by applying a plaster boot cast with the foot at right angles to the leg and slightly everted. Fixation is continued for a period of from four

to six weeks, after which function is gradually resumed.

If the displacement has been present for some time or if conservative measures fail, an operation to replace the tendon is indicated. The technic of Ellis Jones<sup>1</sup> is simple and apparently quite efficient. The operation consists of exposing the tendons in their sheaths and replacing them in their proper position. A tongue shaped section of tendo Achillis is dissected downward from its lateral border. The free end is passed through a drill hole in the external malleolus and sutured to itself, forming a sling which prevents redislocation. In paralytic cases associated with a calcaneovalgus foot, correction of the deformity is all that is necessary.

*Luxation of Long Head Biceps.* Dislocation of the long head of the biceps muscle has been described by Gilcreest<sup>2</sup> and others. But in the experience of the writer it occurs very rarely. The etiology is trauma, either often repeated minute traumas or sudden severe movements of the arm into external rotation and abduction. The symptoms include pain in the region of the bicipital groove which is increased by placing the arm in overhead extension and external rotation. Weakness and disability of the extremity is a common complaint. The diagnosis rests on the symptomatology and proper evaluation of physical findings. There is usually some tenderness over the front of the shoulder in the region of the biceps tendon. Occasionally one is able to palpate the tendon outside the groove or the empty groove itself, which cinches the diagnosis. Unfortunately, these signs cannot be constantly demonstrated because of the presence of overlying structures. Gilcreest has described a test upon which he

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places much emphasis. The patient raises his extended and externally rotated arms over head. A five pound dumbbell is held in each hand. The examiner then places his fingers on the long head of the biceps as the arms are lowered to the side of the body in the coronal plane. When the outstretched arm reaches an angle of 110 to 90 degrees, a snap may be heard and felt in the injured shoulder which is accompanied by acute pain in the shoulder and also in the region of the bicipital groove. Gilcreest considers a positive test pathognomonic of the lesion.

*Treatment.* If the case is seen soon after the accident, replacement may be accomplished by manipulation; and if successful, the arm is immobilized to the side of the body for two weeks. The indication for surgical treatment rests on the degree of disability present. If the patient is a laboring man who must use his arms in heavy work, early operation is the treatment of choice. The purpose of the operation is to replace the tendon in its groove and hold it there by suture of the transverse humeral ligament. Gilcreest advises cutting the tendon high in the joint and suturing the proximal end into the coracoid process and into the tendon of the short head of the biceps. Following operation, a Velpau dressing is applied for about two weeks after which function is gradually resumed.

The condition known as snapping hip, while not definitely caused by a luxated tendon, is a somewhat analagous type of disability. In the writer's experience, the incidence of this affection is very uncommon. These cases are characterized by an audible and palpable snap produced by a tight fascial band slipping forward over the trochanter. Frequently the band can be seen to slip forward. The band usually consists of a thickened portion of the iliotibial band or an accessory slip of the gluteus maximus muscle at its insertion. Treatment is not often required because the condition is not usually painful. However, in one of the writer's cases, the patient was aware of a snapping at the hip for several years before pain developed from

which she sought relief. When treatment is necessary it is entirely surgical. The operation is best performed under local anesthetic so that the patient can reproduce the snap which makes the band easier to locate. While several different operations have been proposed, apparently all that is necessary is to incise the fascial band transversely below the level of the great trochanter and suture the edges to the periosteum to prevent reunion.

#### SEVERED TENDONS

Tendons are usually severed by sharp objects such as a knife, glass, tin, or pieces of porcelain from broken water faucets, or they may be severed by severe muscle pull following some untoward movement or violent exercise. The greater number of tendon injuries from incised wounds occur in the upper extremities; whereas, rupture of muscles and tendons seems to occur more frequently in the lower extremities.

The first and most important step in the treatment of any condition in which tendon involvement is obvious or suspected is a careful examination to determine the extent of the injury. The necessity for this seems clear, and yet one not infrequently sees cases later on with evidence of severed tendons which were completely overlooked at the time of accident.

In connection with open or incised wounds the great danger is the distinct possibility of infection. When it occurs the success of the operation is in doubt and the patient's life may be endangered. Obviously, therefore, one should never repair a tendon in the presence of infection or in a grossly contaminated wound in which infection is likely to occur. As a rule a tendon should be sutured as soon as possible following injury, but many factors must be considered in determining whether a primary or delayed suture should be done. Among these are the character and extent of the wound, the nature and extent of the first aid treatment, the length of time which has elapsed since injury occurred, and last but not



least, the skill and surgical judgment of the operator.

If the wound is a cleanly incised one, sustained indoors, with the patient's skin relatively clean, immediate suture may be performed. On the other hand, in grossly contaminated and dirty wounds a delayed suture is the method of choice. As a matter of general principle, wounds which are more than eight hours old should be cleansed as thoroughly as possible and the superficial tissue sutured loosely, and any tendon repair deferred until complete healing has occurred.

The repair of a severed tendon is a major operation, and the surgeon should have at his disposal all the necessary facilities for carrying out the work. We believe that a general anesthetic is preferable to local anesthesia. It goes without saying that the operator must be thoroughly familiar with the anatomy of the part in question. These operations are often long and meticulous procedures, which tax the skill of the surgeon and the endurance of the patient. We

also believe that some of the poor results following otherwise adequate surgery are due to pulling apart of the tendons following suture. Too little attention has been paid to the proper physiologic and mechanical methods developed for tendon suture. The reader is referred to the excellent work of Koch,<sup>3</sup> Mason,<sup>4</sup> and others for details of technic.

#### SUMMARY

1. The more common luxations of tendons have been briefly discussed.
2. Severed tendons are briefly discussed from a general standpoint.

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# TREATMENT OF INGROWN TOE NAIL\*

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OF all the innumerable ailments to which the human foot falls heir, I know of no condition more aggravating than the common, garden-variety of ingrown toe nail. This occurs, as a rule, on the great toe, either on the inner or outer border of the nail, ranging all of the way from mild irritation by pressure of the nail edge to extensive infection involving the entire toe. Like the popular "athlete's foot," with which it is sometimes associated, ingrown toe nail is placed in the category of conditions expected to be amenable to home treatment. It seems that the patient usually runs the gamut of curbstone advice from his neighbors, shoe fitter or medical friends, with the result that he has tried many measures for relief, most of which are worthless, many of which are definitely harmful and very few of which actually get to the seat of the trouble. A brief description of the condition is in order to clarify the contraindications to the usual bedroom management.

By far, the most common factor in etiology is an increase in convexity of the nail so that the superior surface of the nail, instead of being mildly convex, assumes a definite exaggeration of curvature, particularly at the margin of the nail. This serves to thrust the lateral edge of the nail deep into the perionychial fold (nail fold), and to permit the soft tissue of the toe to roll up over the side of the nail. (Fig. 1C.) This embedded margin of the nail thus presses deeply into the tissue and causes pressure and irritation. As inflammation increases, pressure increases, so that a vicious cycle is established; the more pressure, the more irritation and the farther the nail edge burrows into the tissue. Thus, it is evident that the major aim in treatment must be to

flatten the nail in such a way that the lateral margins will not grow under but will project laterally with only a moderate degree of convexity. (Fig. 2D.) This, in brief, is the aim of any treatment, whether it be preventive, conservative or surgical. Any measure which fails in this is likely to result in failure to correct the condition. This, perhaps, represents an oversimplification of the problem, but for the purpose of this discussion is, in my opinion, entirely adequate.

It might be worthwhile to mention a few of the definitely deleterious procedures which are often advised and carried out, before proceeding to give a summary of proper management for the different stages and degrees of this condition. One of the popular corrective measures for this condition is to cut off the corner of the nail which, temporarily, relieves the pressure of the nail margin on the ulcerated perionychium and does give temporary relief from discomfort. As the nail grows back in, however, the curvature usually becomes more pronounced and the condition is only aggravated. Another popular treatment is to remove the toe nail entirely. This, of course, results in the same thing, since the new nail very often grows in smaller and more convex than the original nail. Another method is to split the toe nail, and to remove the lateral or medial edge of the nail which, again, gives temporary relief and permanent aggravation. These measures are to be avoided rather than adopted.

## TREATMENT

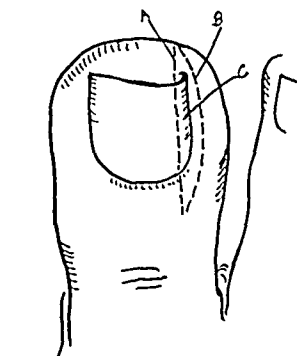
The proper treatment of ingrown toe nails falls into three classifications: first, preventive; second, conservative; third, surgical.

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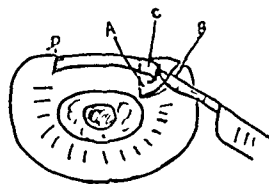
*Preventive Treatment.* Our essential aim here is to prevent increased convexity of the nail with resulting pressure into the down, it should be trimmed fairly close but not rounded, thus leaving the corner of the nail always exposed in the soft tissue and

## SCHEME OF OPERATION

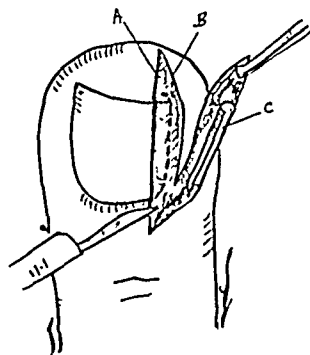
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FOR  
DR. D. H. O'DONOGHUE



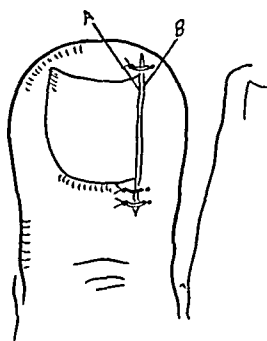
I Showing Incision



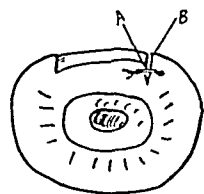
II Cross-section of Incision



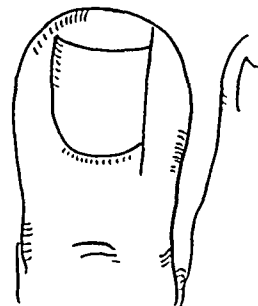
III Removal of wedge of tissue including Nail, Nail-bed, and Nail-fold.



IV After Suture



V Cross-section after suture



VI After Healing

FIGS. 1 TO 6. Scheme of operation.

soft tissues of the toe. Anything which tends to press the toe laterally and roll the soft tissue over the edge of the nail will tend to cause an ingrown toe nail. Some of the most common causes for this condition are: a short shoe, which forces the great toe laterally against the second toe; a too narrow shoe which accomplishes the same result in a different way; a short sock or too great lateral deviation of the inner border of the shoe caused by a pointed shoe. Obviously then, the proper means for prevention of ingrown toe nail is to insist on a well-fitted shoe, neither too narrow nor too short, and a comfortably fitted sock which does not force the toes together when the foot is thrust into the shoe. In order to prevent the corner of the nail from curling

not buried. The toe nail should not be rounded as is the finger nail. Any gross disturbance of function of the foot, such as pronation of the forefoot, uneven weight bearing, etc., can result in trouble about the toes by throwing an increased burden of weight on the medial border of the foot so acting to force the soft tissues over the nail margin. Any static imbalance of the foot can be a contributing factor and should be corrected. Proper hygienic care of the foot is, of course, essential, and any cause for irritation about the eponychial tissue should be carefully treated, since any distortion of growth of the nail may result in increased convexity with resulting trouble along the nail margin. If the nail has a tendency to be thick and so have

more tendency to curl, the nail should be shaved flat along the convexity of the superior surface. This is done either with

in order to cause it to flatten. At the same time, as the central portion of the nail is being thinned down, very delicate pressure



FIG. 7. Typical result on outer margin of toe, right foot, six months after removal of ingrown toe nail.

an ordinary emory board or with a sharp knife, the main point being to reduce the actual thickness of the nail along the key of the arch, which is the superior surface of the nail in the mid line.

*Conservative Treatment.* This classification represents simply an advance from the previous group of preventive treatment, and the same prophylactic management is advisable here as above. However, we are now faced with an actual fait accompli, i.e., an ingrown nail. The problem here also is to reduce the convexity of the nail and so relieve its irritation. If there is acute infection about the nail, measures to control this should be instituted, such as bed rest, hot packs, etc. Provided there is no acute infection present or that this is well under control, we can proceed with other measures which we may hope will cause some relief or even a cure. It is, in my opinion, imperative that the arch of the nail be broken down by thinning the nail in its central portion. This should be carried out meticulously and the nail should be thinned down until it is paper thin in the central portion. This is much better than cutting a section out of the central portion of the nail

should be instituted under the lateral margins in an attempt to elevate it away from the soft tissue. This can be done by very careful insertion of a cotton layer completely under the lateral edge of the nail at its distal end. Great care should be taken not to force in a hard plug of cotton which will increase the irritation and increase the pain. A complete layer of cotton first is inserted entirely under the edge of the nail as a protecting pad, and then as elevation is gradually secured, more cotton can be applied until the nail edge is lifted well away from the nail matrix. The nail should be trimmed straight across, great care being taken not to break off the corner of the nail, since if this occurs, it is difficult to progress with the elevation of the corner of the nail until it has grown out sufficiently to permit insertion of cotton under the corner. After the acute condition is once controlled, care must be taken to prevent a recurrence of the convexity of the nail. It may be necessary for the patient to continue to keep the nail flat and thin in the central portion and to keep a little cotton under each corner of the nail. Here, again, it is extremely important that the shoe be

well fitted, not too tight, not too short and that any imbalance of the foot be corrected.

*Surgical Treatment.* If the condition is intractable and will not respond to conservative treatment, or if the nail is so obviously deformed that conservative treatment will fail, surgical treatment should be resorted to and offers the promise of a very excellent result. It is extremely important to eliminate any active infection prior to surgical excision, since the proper surgical procedure necessitates a considerable incision and one hesitates to do this when there is acute infected tissue. There are many operations for relief of this condition and many of them are excellent.

The requirements of the operation are as follows: It should relieve the overgrowth of the perionychium over the lateral margin of the nail; it must remove a section of the lateral margin of the nail sufficient to get back to fairly flat nail; in other words, remove the convexity of the margin; it is absolutely essential that the nail bed and root of this excised portion be entirely removed at the time of the operation. If it is not removed, the nail growth will recur with a very excellent chance that the deformity will return with it or, more likely, result in spur formation. One cannot stress too much the absolute necessity for eliminating entirely the nail bed and root of the resected portion.

The operation which I have employed with a great deal of satisfaction is as follows: Great care is taken in preparation of the toe to clean up infection around the toe nail and to secure as much cleanliness as possible. Operation is usually done under a local anesthetic, using 2 per cent novocain (with adrenalin, if there is no evidence whatever of any peripheral vascular disturbance). The anesthetic must be a block around the base of the toe rather than local infiltration. The block should be carried out by two dorsal punctures, the local block entirely encircling the base of the toe. The original incision begins about  $\frac{1}{4}$  of an inch proximal to the eponychial margin, the exact distance depending on the length of

the nail root. (Fig. 1A.) It is imperative that this incision extend proximal to the nail root. Incision is carried through to the periosteum, extending along the dorsal surface of the toe nail linearly, paralleling the lateral edge of the toe nail. The exact line of incision depends upon the degree of convexity of the nail. In the ordinary case, some  $\frac{3}{16}$  to  $\frac{1}{2}$  of an inch of the lateral portion of the nail is included. Incision is carried throughout the length of the nail and over the end of the toe for approximately  $\frac{1}{4}$  of an inch. (Fig. 1A.) The second incision is made lateral to the nail margin at such an angle so that the depth of this incision will meet the depth of the first incision. (Figs. 1B and 2B.) In other words, a triangular section of tissue is removed (Figs. 2C and 3C), including the lateral margin of the nail, the perionychial redundancy and the soft tissue down to the periosteum. After removal of this section of the soft tissue, this section should include toe nail, nail bed, nail root and the perionychium. This will leave a gaping wound which shows no evidence of nail bed or nail bearing tissue. (Fig. 3.) The wound is carefully inspected to be sure there are no residual portions of nail bearing tissue and the wound edges are partially approximated by a stitch or two proximal to the nail and one distal to the nail. (Figs. 4 and 5.) In the ordinary case, this will leave a gap along the nail margin of about  $\frac{1}{8}$  of an inch between the edge of the nail and the lateral incision. This area is allowed to granulate in and the ideal result will consist of a flat toe nail with no redundancy of the perionychial tissue. (Figs. 5 and 6.)

After treatment consists of ordinary dressing until the wound is healed. Usually, it is advisable to keep the patient off his feet for a few days, particularly if it is necessary to resect both sides of the nail or if the condition involves both feet. Following a successful removal (Fig. 7), there should be no tendency whatever for return of deformity. If all the nail bearing tissue is not removed, spur formation will result which will necessitate local removal.

# BONE SINUSES AND THEIR TREATMENT

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I DO not think any physician doing bone surgery has even a feeble interest in the subject of bone sinus except when he has one to treat, and then it is his earnest wish to pass it on to his worst enemy. History has shown that it has been a serious problem for all of us, which accounts for the numerous methods that have developed. I will admit that probably I have had as many, if not more bone sinuses to treat than most men.

Before the World War our attempts at treatment were more or less pathetic, results indefinite and our patient's confidence in us more or less shaky, and I am afraid they are still so to some extent. Even now, some of the looks received from patients as the condition fails to show the improvement promised, do not leave one feeling too sanguine.

During the War, at one time when I was working with the British at Alder Hay Military Hospital, Liverpool, England, we had about 325 cases of acute and chronic osteomyelitis under our observation and were getting no where.

Rutherford Morrison of Newcastle, England, was at that time perfecting his method, which was becoming successful. I obtained permission from my Chief to go there and study the method. Mr. Morrison made no restrictions as to the patients to treat, but treated them differently according to conditions found. It was called the Morrison "Bipp" treatment. In the chronic bone type which is continuously discharging, x-rays would be taken as a diagnostic medium. Sometimes a sequestrum was in evidence, sometimes not, and in many instances when not shown in x-rays, it would be found in the field nevertheless. Morrison laid stress upon the fact that the thing of greatest importance was to be sure to re-

move all dead bone, otherwise, even his method was not successful.

## TECHNIQUE

First, when a tourniquet can be used, it is advisable to use one not more than an hour on the arm, but two to three hours on the leg. This produces a dry field and the difference between dead spicules and sclerosed bone as against normal bone can easily be determined.

Run a probe down into the pocket and leave it there. Then make a generous incision down to the bone, above and below meeting at the probe and carefully peel away the soft structures and periosteum to obtain a good view. The opening in the bone may be quite small but the pocket fairly large, in which lies the sequestrum. It will be necessary in many instances to use hammer and chisel, to enlarge the opening materially; in fact, it is advisable to do so in order to have a clear field. Smooth and round out the edges of the opening. Investigate the cavity very carefully, thoroughly curetting the pocket, which may be found lined in some direction with sclerosed bone, which presents an ivory color and is as hard as ivory. This must all be chiseled away until normal spongy bone is reached. When the surgeon is satisfied that he has a healthy field in which to work, he can drench the pocket with full strength alcohol and dry out the cavity thoroughly.

Spread bipp\* on a piece of gauze, rubbing it into the gauze; transfer this paste in the gauze all through the cavity, making a thin film all through the bone and muscle tis-

\* The composition of bipp is one part bismuth subnitrate, two parts iodoform and q.s. paraffin oil sufficient to make a thick paste. Some companies in this country are selling bipp, but use vaseline as a base; it will not work satisfactorily. This preparation must be mixed thoroughly until it has a complete yellowish color.

sues. Prepare the abdomen by cleansing it with a one in two carbolic acid solution, the same as was done to the field of operation, which I failed to mention before. Then make an incision and remove a pad of fat sufficient to more than fill the cavity. Care should be taken not to bruise the fat tissue more than necessary. Place the fat in the cavity so that it fills the whole area and clip off the extruding fat level with the bone. After this remove the fat, gently rub the bipp over its outer surface and replace it in the cavity. Following this apply the bipp to the outer tissues and close the wound with interrupted silkworm gut sutures. Where there is any tension of the skin, undermine the soft parts which will give more tissue in closing. After closure put on a heavy fluffy dressing and leave it alone for ten to twelve days. There will be some discharge in the dressings during that time, but even in the presence of pus the tissues will show healing. In this manner work is cut down in the hospitals tremendously. If structures cannot be closed without tension, use the Orr treatment.

Chutro of Paris worked out a system which I saw at Savenay, France. Whether it was his or Carrel's idea, or both, I do not know; but he made a long saucerized area in the bone, washed it out with green soap and water and packed the whole area with gauze soaked in Carrel Dakin solution. This was repeated every second or third day, and from what I saw is a very painful procedure.

The Carrel Dakin drip treatment is familiar to all of us. My difficulty in using it has been to know how long to use it and when to do a secondary closure. If there is still a discharging sinus, we must go in and find the offender.

The Orr method of treatment described by Winnett Orr of Lincoln, Nebraska, with which we in this country are all thoroughly familiar and which does not call for description, is very successful. I have used it many times on selected cases, and Dr. Orr

deserves considerable commendation for working it out.

*The Maggot Treatment.* It is not necessary to go into that except to say that the author of this treatment deserves just as much credit for his explorations along this line as any other man, and he may be using it very successfully. My difficulty was in proving to my patients that one live animal could live on another successfully to the benefit of each. It was just one of those things where psychology entered into the matter. Our difficulty, after getting the maggots into the finest of wire cage over the affected area, was to try to find out where they had gone when we checked up the following morning. Hence this method had to be eliminated. I am not condemning this method but it was not successful in my hands.

#### CONCLUSION

Probably some one of our associates has found a perfect cure for this condition. If he has, will he please publish it. It is one of the most trying conditions to deal with and so far, is not 100 per cent successful. My own method in these cases is the following: Assuming that it is a chronic bone sinus, I take a plain x-ray and see if it shows a sequestrum. At the same time I also inject into the sinus "Beck's Paste" which may surround the spicules, but also shows the ramifications of the sinus. Sometimes in doing this I have been very pleased to find that the Beck's Paste has succeeded in closing the sinus entirely. I have tried silver nitrate sometimes successfully where Beck's Paste has failed to obtain results. I have used a saturated solution of potassium permanganate irrigation with fair results; I have used peroxide of hydrogen followed with potassium permanganate with occasional good results; I have used autogenous vaccine, occasionally with good results. I have obtained fair results in trying all of these, but none which I would consider a cure-all.

# TREATMENT OF SIMPLE SHOULDER SPRAINS

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THE following is a brief consideration of the treatment of shoulder sprains and a complication, occurring not infrequently, which is a scapulohumeral fibrosis or stiff shoulder. These injuries are commonly seen in office practice and usually arise from straining in lifting or shoveling or result from falls, twisting or striking the shoulder.

Pain is the principal complaint and is expressed with the shoulder at rest or in motion; discomfort may be immediate or it may develop several hours or days after injury. Subjectively, acute or aching pain is experienced over and through the entire shoulder girdle, or may be limited to a point around the acromion, or extend down the region of the deltoid to above the elbow or palpation over the long head of the biceps, or sometimes is localized to the posterior aspect in the region of the scapula and occasionally at the root of the neck. Subjective discomfort is increased with abduction of the arm or carriage of the arm to full, overhead position. Motion is sometimes accompanied by muscular spasm and in this instance limitation of varying degrees is encountered.

In long-standing cases of a month or more in duration, the arm is frequently held in the anatomic position at the side of the body because of subjective pain that is produced on motion. This may result in considerable "stiffness" of the shoulder or what we like to term a scapulohumeral fibrosis. This is similar to Dr. E. A. Codman's "frozen shoulder" and is characterized by greatly limited motion of the arm, particularly in abduction, overhead position and internal rotation. Outwinging of the scapula is present on abduction of the arm and when the arm is passively raised the whole shoulder girdle is lifted.

## TREATMENT

Treatment of the sprain, either acute or "chronic," is directed to achieve a two-fold purpose: to relieve pain and restore motion. In the event that pain and discomfort are intense after injury, the shoulder is exposed to infra-red heat for approximately twenty minutes and then supported by means of a sling. Adhesive taping is avoided. Codeine and aspirin are given in liberal amounts and the patient instructed to use dry heat, electric pad or hot water bag at home. He returns at two or three day intervals for infra-red heat or diathermy and massage therapy. The sling is usually discarded within a week. Not infrequently, full passive motion is readily achieved, but actively the patient experiences "weakness" in holding the arm in abduction or in overhead extension. The addition of sinusoidal stimulation to the musculature about the shoulder girdle is beneficial in these instances.

Briefly, the technic of massage and the exercises to increase shoulder motion are summarized as follows:

1. Twenty to thirty minutes of infra-red heat exposure.

2. Massage first the involved upper extremity, starting at the hand, using a circular movement and working up to the shoulder. Incidentally, use a suitable massage cream and after treatment wash off the cream with 70 per cent alcohol.

3. Holding the patient's arm in an overhead position, the anterior portion of the chest is massaged, using a circular motion.

4. With the patient's arm in abduction exert traction on it with one hand and with the other hand "iron out" the axillary region, using a stroking motion.

5. The patient sits down in front of a table, folds his hands on the table top with



head bent forward. Massage the musculature over the scapular region.

6. With the patient in a sitting position and the physician behind him, grasp both elbows and commence circular movement of the patient's arm, first in clock-wise then counterclock-wise direction.

7. Employ passive internal and external rotation of the arm.

The active exercises which the patient can do at home are:

1. Wall creeping: The patient faces a wall at about a foot's distance, places palms of his hands flat on the wall and works them in a creeping movement as high above his head as possible. He should attempt to increase the height each day.

2. Standing sideways the hand is placed flat against the wall and upward creeping commenced.

3. Two pulleys are rigged in the ceiling of a porch or basement and placed about four feet apart. A rope is strung through them, a weight (starting with one pound) is attached to one end; the patient grasps the other end raising and lowering weight and permitting his hand to be pulled as high above his head as possible. Weight is increased daily or weekly as improvement is noted.

If a scapulohumeral fibrosis is encountered, either from a neglected sprain or one which fails to respond to the usual therapy, shoulder wrenching and manipulation under deep general anesthesia is indicated. Such an operative procedure is used to break up adhesions and passively produce full shoulder motion. X-rays are first taken

of the shoulder to rule out bone pathology. The technique follows:

The patient is given ether and thoroughly relaxed. While the assistant anchors the scapula by placing the heel of his hand against the outer border of the scapula, the operator grasps the upper third of the arm with both hands and slowly and with even pressure, gradually forces the arm into a full overhead position. Distinct "cracking" is often heard during these maneuvers as the scar tissue and adhesions break down. The danger of fracture or dislocation is negligible as long as care is taken not to hurry or to use a jerking force against the arm.

Postoperative care consists of the usual routine and the tying of the wrist above the head of the bed to maintain an overhead position of the arm. This is continued for about four to seven days, after which the patient can report to the office for follow-up treatment, of heat, massage and exercises. No slings or braces are necessary.

Results are usually satisfactory, and even in shoulders that have been fibrosed or frozen over a period of several months or more, good functional shoulder motion can be achieved by wrenching and follow-up care.

The length of disability and treatment required for simple sprains may vary from a week to several months. Usually, in individuals who are advanced in years or who are muscular and heavy, the recovery period must be expected to be longer. In those patients requiring shoulder wrenching and follow-up care, recovery may extend over four to six months.



# BURSITIS

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THIS paper attempts to give the views of an industrial surgeon, based on twelve years of experience in association with Dr. C. R. G. Forrester, Dr. A. H. Mason and recently with Dr. C. C. Coleman. During this time we have examined or treated about 3000 industrial patients a year, about a fourth as many private patients and have had occasion to handle many examples of bursitis among the other lesions. We have had to work out certain basic rules of treatment to simplify therapy and to learn by precept and largely by experience the most efficient and successful methods of achieving satisfactory results. Bursitis is common, particularly the olecranon and prepatellar types; it is often poorly treated by the general practitioner; it is a lesion suitable for office treatment in most instances, as only the severe infections and most surgical excisions require hospitalization.

*Definition of Bursa.* Dr. John Homans, a valued teacher of mine, in his Textbook of Surgery, 1931, defines a bursa as "a thin-walled fibrous sac lined with a specialized layer of cells which secrete a thin synovial fluid and under normal conditions the opposing surfaces glide freely over one another. Its function, like that of the synovial sac of a joint, is one of lubrication. Bursae are so disposed in various parts of the body, between structures which muscular effort causes to glide upon each other, that undue wear and tear upon the opposing tissues is prevented. Thus they are found between subcutaneous tissue and a joint capsule, between a joint capsule and bone, between bone and overlying soft tissue parts, between crossing tendons, and even between muscles. They frequently communicate with joints."

*Causes of Bursitis.* The causes of bursitis may be tabulated as follows:

1. Traumatic
  - (a) Actual wound of a bursa; of puncture, contused, incised or lacerated type
  - (b) Direct contusion over bursa
  - (c) Sudden violent motion or twist
  - (d) Repeated minor traumas
  - (e) Overuse sufficient to cause irritation
2. Infectious
  - (a) Common pyogenic organisms
  - (b) Gonococcus
  - (c) Tubercle bacillus

3. Toxic

Obscure or biochemical disturbance elsewhere in the body; nonbacterial, but otherwise resembling infectious bursitis. Distant foci of infection, or absorption of abnormal substances by the intestinal tract may have an influence (Homans).

*Description and Complications.* A contusion over a bursa is often sufficient to cause a fluid extravasation into the bursal sac (a yellow sticky fluid of synovial type). A more severe contusion causes blood extravasation into the bursa. The wounds of bursae most commonly seen are small, often caused by a blow from a blunt object, as in a fall, or by some sharp object causing a puncture, as in kneeling on a nail or tack. A bursa can become infected from a simple contusion (rare), but a puncture or contused wound into a bursa is the most frequent cause of the troublesome infections seen in this sac. If the infection stays confined to the bursa, a purulent material fills and bulges it; if the infection spreads through the sac wall, a more or less extensive cellulitis ensues and even forms a widespread abscess which follows the tissue planes, either in the subcutaneous or in the deep fascia. All too often uncontrolled or neglected bursal infection will smoulder along for several weeks and finally involve

the underlying bone (olecranon chiefly). In one case we found the entire olecranon process and the proximal fourth of the ulna osteomyelitic, and pus had invaded the elbow joint. A chronic bursitis leads to bursal wall thickening, tabs, villous enlargements, adhesions, or even calcareous deposits in the bursa, or a spur on the underlying bone.

*Diagnosis of Bursitis.* In general, bursitis is diagnosed by the history, together with the signs of swelling, tenderness, redness if inflammatory reaction has occurred, slight to moderate pain on motion of the underlying joint, the pain occurring when the joint position puts a stretch or pressure on the bursa, as flexing the elbow in olecranon bursitis, flexing the knee in prepatellar bursitis, hyperextending the knee in popliteal bursitis or abducting the arm in subacromial bursitis. A puncture or contused wound over the region of the patella or olecranon should always be watched closely for a possible invasion of the bursa with either a simple bursal effusion or more likely a purulent infection in the sac. A typically swollen bursa forms a rounded prominence, moveable, often of large size at the patella and olecranon, fluctuant and only slightly tender. In chronic bursitis the sac often becomes thickwalled and is "pebbly," "wormy," or "gritty" to palpation because of the presence of tabs or villous thickenings in the bursal lining.

#### TREATMENT

I wish to condemn most strongly the common practice of aspirating bursal effusions, except where fluid is wanted for diagnosis of possible tuberculous, gonococcal or other rare cause. In the first place, the aspirated fluid is replaced in a few hours by more fluid produced by the irritated or injured synovia; secondly, the single or repeated needlings of a simple uninfected bursal effusion frequently leads to the unfortunate result of an infected bursa, with the possible complications already mentioned. Needless and dangerous aspira-

tions are done by many practitioners. Stab drainage or incision alone is also contraindicated in my opinion.

1. *Conservative Treatment.* We treat a simple or uninfected bursitis of the olecranon or prepatellar type (which are the most commonly encountered), where there is no open wound into the bursa, by a rubber sponge pressure dressing applied as follows: For example (olecranon), apply sheet wadding around the elbow, or wrap the sponge in a clean bandage to keep the rubber from direct contact with the skin; then apply the sponge rubber pad over the swollen bursa. The pad is cut to shape from an ordinary red rubber bath sponge and should be larger than the bursa. Bandage the sponge into place to compress the bursa firmly, taking care not to embarrass the circulation of the extremity, (we use a cotton and gauze pad at the antecubital or popliteal region); rebandage every two or three days. The sponge expands as the swelling of the bursa subsides, and thus exerts a continuous elastic pressure which in our experience effects a cure in two or three weeks, and is much more effective than the former methods of hot packs, hot baths or aspiration. A saturated solution of potassium iodide in doses of ten to fifteen drops by mouth three times daily is a useful adjunct as it hastens the resolution of the effusion and bursal thickening. If the patient has to continue at his work, we use the bandage-covered sponge held in place over the bursa by an elastic bandage or a well-fitted elastic supporter (for the elbow or knee), thus allowing fairly good joint motion during the cure.

X-ray is always advisable in diagnosis, as a check on treatment, to determine bone injury, development of a spur under the bursa (this is not uncommon at the olecranon), fracture of a pre-existing spur or signs of cortical osteitis or osteomyelitis. If the bursitis does not subside quickly, progress x-rays are strongly advised.

If a bursa is acutely inflamed, with or without a surrounding cellulitis or lymphangitis, we use continuous hot boric

fomentations and elevation and rest of the member, until such time as the inflammation has subsided or become localized to the bursa, whereupon bursectomy is usually indicated for a cure.

2. *Surgical Treatment.* Aspiration and simple incision of a bursitis usually are not curative; nor is the injection of sclerosing solutions nor simple curettage effective. We do a complete excision of the long existent bursitis, as in occupational bursitis, when the conservative measures have been given a fair trial (two or three weeks) and proved ineffective. Where there is no infection, simply a localized nontender simple bursal effusion or simple chronic bursitis, the bursectomy can be done in the office or hospital under local anesthesia. We use 2 per cent novocain in the skin and around the borders of the sac. Where there is any question of infected material in the picture, the bursectomy should be done in the hospital under general anesthesia. In operating, we always use a curved or semilunar incision, approximately in line with the bursal edge and extending halfway around its border. We carefully dissect back the flap of skin and fat in one layer over the whole bursa, taking care not to button-hole the skin, then dissect out the whole bursa in one mass, taking it off the underlying bone or fascia cleanly, tie all bleeders with small plain catgut and close the skin with interrupted silk sutures. We insert a small rubber dam drain to allow escape of extravasating blood and serum. This drain can be removed in forty-eight hours; the sutures are removed on the seventh day and the skin then cross-taped with butterfly adhesive strips for a further period of seven to fourteen days. This adhesive support prevents scar spreading, which is prone to occur with elbow or knee flexion. The curved incision is so placed that it will not leave a scar directly over a bony prominence, as olecranon or patella, and to avoid pain on kneeling, bumping or friction. The radical removal of a bursa, if done on these general principles, gives a good functional result, allows full motion

of the joint and the scar is freely moveable in a few months.

In olecranon bursectomy we advise placing the arm over the patient's body, while operating (attach the hand to the other side of the table by a soft roller bandage around the wrist), thus making the operative approach easy. Make a posterolateral curved incision and stay away from the ulnar nerve, which lies in a tunnel or groove only about a half inch from the medial edge of the bursa. The bursa will be found firmly attached to the bone and triceps reflection.

Where a purulent infection in the bursa has invaded the underlying bone, the operation includes not only total bursectomy but curettage of all infected bone. This complication is beyond the scope of this paper, and must be treated by one of the accepted methods for osteomyelitis, preferably the Orr method of saucerization and vaseline pack. If only a small area of the cortex is involved, we sometimes treat this with Bipp\* after curettage. After bursectomy and bone curettage, the area is drenched with 70 per cent alcohol, dried, then the Bipp is spread on gauze and rubbed thoroughly into the bone surface, the excess Bipp wiped away and the skin closed in the usual manner without drainage. This is the Morison method of treating osteomyelitis. The bismuth and iodoform are slowly absorbed and act as mild antiseptics, so that the wound heals almost *per primam* with very little drainage of pus or serum. If bursectomy is done in the office (and never on infected bursae), it must be done under as strict a surgical technic as in the hospital in order to be successful.

Instead of using Bipp, when we deal with potentially infected fields in bursectomy, we sometimes use iodoform-ether solution (formula is 29.75 cc. of sterilized powdered iodoform to 118.30 cc. of ether), drenching the deep tissues with this before closure of the wound. The ether is a good fat solvent

\* Bipp is an abbreviation for bismuth iodoform paraffin paste consisting of bismuth subnitrate 1 part, iodoform 2 parts, and mineral oil q. s.

and diffuses into all areas of the wound. As it volatilizes, it leaves a film of iodoform in the tissues to act as a slowly absorbing antiseptic.

One should be familiar with the workmen's compensation law of the state in which one practices, as it has a bearing on the handling of bursitis cases in industrial practice, particularly occupational bursitis. The insurance carrier for the employer in question may deny liability; for instance, in Illinois, employers may or may not carry "occupational disease" coverage in their compensation policies. This matter of liability should be checked through the insurance carrier before you enter on the treatment of the industrial bursitis case, to determine who is to pay the cost of medical care.

#### BURSITIS BY REGIONS

1. *Shoulder Bursae.* (a) *Subacromial or subdeltoid bursitis* is not uncommon but should be distinguished from other affections of the shoulder. This bursa is about the size of one's palm and lies under the deltoid muscle and acromion process which form its roof, and over the attachment of the supraspinatus tendon which forms its floor. Bursitis here can be of toxic origin, come on suddenly from obscure causes, with acute pain, sometimes crepitation, inability to abduct and rotate the arm outward, tenderness and indefinite swelling or no swelling, and early deltoid atrophy. This toxic bursitis usually responds quickly to rest and heat. If it lasts longer than a few days, it should be treated in an abduction splint, especially in a person over forty.

A shoulder twist or sprain is sometimes severe enough to injure the supraspinatus tendon attachment to the greater tuberosity of the humerus, with or without a cortical tear, and can wholly or partially tear loose this tendon. In so doing, it invariably injures the floor of the subacromial bursa, causing the characteristic signs pointed out by Codman in his book on supraspinatus injuries; faulty abduction, pain, swelling, spasm and hesitancy on

abduction. This combined bursal and tendinous injury can be treated conservatively by forward abduction in an airplane splint, heat and rest, followed by increasing exercises off the brace as the pain subsides; or if intractable pain and loss of abduction persist, it can be treated by Codman's operation on the tendon, together with resection of as much of the damaged bursa as can be reached.

Chronic subacromial bursitis often shows by x-ray a characteristic proliferation of bone or calcareous deposits close over the greater tuberosity of the humerus.

We find that most of these bursal irritations respond well to conservative treatment. An abduction brace (airplane or Littler Jones splint) is often necessary for six to eight weeks, or until the patient is able to elevate the arm under its own power off the brace and hold it in full abduction for at least five minutes. Then we remove the brace and continue infra-red heat lamp and massage treatments at two day intervals, combined with passive and active exercises, till restoration is complete. The shoulder can compensate for a rather severe supraspinatus and bursal injury under a conservative program.

Carefully differentiate a true subacromial bursitis from other lesions such as: traumatic synovitis of the shoulder joint proper, arthritis, scapulohumeral fibrosis, acromioclavicular separation, rupture of the supraspinatus or infraspinatus, or of the long head of the biceps, muscle sprain, brachial neuritis, myositis and myalgia. One important contrast is this: In true shoulder joint involvement, which is intracapsular, the characteristic tender point is anteriorly over the region of the long head of the biceps brachii; in subacromial bursitis, the tenderness is under the middle belly of the deltoid, that is laterally at the shoulder.

(b) *Other shoulder bursae* are rarely inflamed compared to the subacromial. Coracobrachialis bursitis causes anterior pain and localized tenderness; acromial bursitis is seen as a result of habitual fric-

tion or weight bearing on the shoulder (as in porters and hod carriers). This causes an adventitious bursa to form between the calloused skin and the acromion, and the sac can be excised if painful.

2. *Elbow Bursae.* (a) *Olecranon bursa* ("miner's elbow"). This is very commonly involved in bursitis, is often injured by a fall contusing or wounding the bursa, or irritated by repeated knocking of the elbow against objects, as in working with tools in close quarters (miners, plumbers). This bursitis is easily diagnosed by its rounded, fluctuant prominence over the point of the elbow. The bursa is located between the skin and the tendinous expansion of the triceps insertion over the olecranon. The bursal floor is usually firmly adherent to this aponeurosis and often has vertical fibrous bands tying it to the olecranon, a point to watch in dissecting out the bursa. A wound of this bursa should be treated carefully as it can become infected very easily and result in a nasty infection invading the bursal wall. Rarely a widespread cellulitis of the arm can involve the olecranon bursa, invading through its wall. A simple uninfected olecranon bursitis we treat conservatively by sponge pressure; if chronic, intractable, or infected, we treat by bursectomy.

(b) *Radiobumeral bursitis* ("tennis elbow") was described by Dr. Robert Osgood of Boston. This bursa is located between the common tendon of the extensor muscles of the fingers and the supinator brevis muscle, overlies the radiohumeral joint and is irritated by repeated violent extension of the wrist in the pronated position, as in using a tennis racquet. This bursitis causes severe pain and localized tenderness, and disables the arm for tennis sometimes for several months. Treatment is by prolonged rest, heat and supportive dressing. It is liable to recurrence. Radical cure is by bursectomy.

(c) *Other Bursae at Elbow.* The interosseous and bicipitoradial bursitis types are mentioned by John Homans and others as occasionally found but they have been

rare in my experience. The cause is the irritation from repeated violent motions of the arm, as in pitching base ball. There is localized pain on contraction of the biceps with the forearm pronated. The ulnar and radial bursae in the hand are really tendon sheaths and should be treated as such. Their inflammations are outside the scope of this discussion.

3. *Hip Bursae.* (a) *The gluteal bursa* lies between the great trochanter and the origin of the gluteus maximus and vastus externus muscles, is large, constant, and subject to trauma from blows or falls, and when inflamed it causes pain at this location on flexion and internal rotation of the hip. There is localized tenderness and swelling of the bursa. Gluteal bursitis is rare in my experience. It is seen occasionally as a complication in hip fracture. Rule out hip fracture, osteomyelitis or hip joint disease by x-ray. If this bursitis does not yield to rest and hot applications, it can be cured by excising the bursa. I had to remove this bursa once in doing a fixation of a slipping iliotibial band for "snapping hip."

(b) *The iliopsoas bursa* (iliopsoas bursa) is large, constant, and lies between the iliopsoas muscle and the Y-ligament of Bigelow at the hip. When swollen it may simulate a psoas abscess or femoral hernia. For comfort the patient flexes and externally rotates the thigh. The disease is uncommon. If chronic, the bursa can be excised, approaching it along the inner border of the tensor fasciae femoris, well lateral to the femoral vessels.

(c) *The ischial bursa*, when inflamed, causes a characteristic disease variously called "Weaver's Bottom," "Tailor's Bottom" or "Lighterman's Bottom." The irritated bursa may reach a large size. The bursa lies between the ischial tuberosity and the origin of the hamstring muscles, and is in contact with the deep surface of the gluteus maximus muscle. A sitting trade and horseback riding can cause such bursitis. I saw one instance following a heavy fall in which the patient landed in a sitting position. However, the bursal swell-

ing subsided over a period of about three months. The pain in ischial bursitis is probably caused by pressure on the inferior pudendal nerve. Bursectomy here is difficult due to the deep location and the rich blood supply adjacent.

4. *Knee Bursae.* (a) *Prepatellar bursitis* is very common. It often follows repeated or occupational trauma especially by kneeling work, hence the name, "housemaid's knee." I have seen it in janitors, plumbers, bricklayers, carpet layers and cleaning women. The swelling is often very large, forming a "hydrops" of the bursa. Puncture wounds of this bursa (as from kneeling on a tack or nail) are a common source of the infectious bursitis. Rarely the bursa is secondarily infected from a surrounding cellulitis. The sac lies between the skin and the deep fascia overlying the patella and is usually closely adherent by tough fibrous strands to the bone or deep fascia (quadriceps aponeurosis). Conservative treatment is by sponge pressure, in the simple uninfected bursitis cases; radical cure is by complete excision of the sac. Aspiration treatment is highly inadvisable. Incision and drainage alone, curettage and injection of sclerosing chemicals are useless in effecting a cure.

(b) *Infrapatellar bursitis* is not so common as the prepatellar type. This bursa lies between the patellar tendon and the anterior surface of the tibia above the tibial tuberosity, and is separated from the anterior chamber of the knee joint by a thick pad of fat. The bursa is inflamed or swollen at times from the repeated traumas of a kneeling trade, can also be infected from a puncture wound, and is sometimes inflamed in connection with Osgood-Schlatter disease (tibial tuberosity epiphysitis of adolescence). This bursitis is characterized by swelling, local tenderness and pain on kneeling, or on pressure over the patellar tendon region, not over the patella itself. A simple infrapatellar bursitis usually responds to sponge pressure dressings. If infected or chronically persistent, it can be excised easily, taking care to place the

incision laterally or medially to avoid injury to the patellar tendon, to keep out of the knee joint and to leave a scar that will not be pressed on kneeling.

(c) *The Bursae of the hamstrings* can be irritated by overexercise or strain of the knee. These bursae are small, their swelling is usually brought out to inspection and palpation by having the patient hyperextend the knee. There are many bursae here that may become involved in bursitis. There is tenderness on pressure, pain on knee extension, and knee flexion relieves pain and causes the swollen bursa to sink out of sight (except the biceps bursae). The bursa anserinus (between the semitendinosus tendon and the tibia), the semimembranosus bursa, and the gastrocnemius bursa, the superior and inferior biceps bursae can be involved. The latter may be injured by a direct blow or squeeze, and this bursitis shows as a swelling overlying the head of the fibula. The popliteal bursa is really a long saccular extension of the knee joint posteriorly under the popliteus muscle, and at operative removal this communication with the knee joint must be recognized and ligated. Patients with popliteal or any posterior knee bursitis are inclined to relieve pain and bursal pressure by walking and standing with the knee partly flexed. We have seen only two cases of popliteal bursitis in the past twelve years, and two cases of the medial hamstring type. Distinguish these bursal enlargements carefully from popliteal tumor, varix, aneurysm, abscess, hematoma and rupture or bulging of the posterior capsule of the knee.

There is a so-called rider's bursa, but this is an adventitious sac superficially placed between the inner femoral condyle and the skin, seen in horseback riders.

We have not been successful in curing the enlarged bursae behind the knee with sponge pressure, or other conservative measures. Radical excision is curative and requires good knowledge of anatomy.

5. *Ankle and Foot Bursae.* (a) *The Achilles bursa* is located between the

Achilles tendon and the posterior tubercle of the os calcis. It is irritated frequently by the wearing of stiff new shoes; it can be irritated from unaccustomed long walking or running, also by learning to skate. I saw one young man with bilateral Achilles bursitis caused by his work as delivery boy for a drug store. Walking casts were required for eight weeks. Heat, rest and protective treatment almost always cure the lesion; if intractable, bursectomy will cure but is seldom necessary. Watch for Achilles contracture and consequent foot drop deformity; keep the foot up to a right angle to prevent this.

(b) *The subcutaneous heel bursa* lies between the tendo-Achilles insertion and the skin. It can suffer the same irritations as the Achilles bursa. It responds readily to conservative measures. Its swelling is usually smaller, more superficial and distally placed than the sub-Achilles type. It occasionally becomes infected and requires incision or excision for a cure. If excision is done, place the scar where shoe pressure will not irritate the scar.

(c) *Bunion*, associated with hallux valgus, is a thickwalled adventitious bursa lying between the calloused skin and the deformed first metatarsophalangeal joint. It is caused by the constant pressure of ill-fitting shoes, and such shoes keep up the irritation. Such a bursa may become grossly

infected and require incision and drainage before the recommended radical operative cure can be undertaken. This operation for bunion and hallux valgus should be performed on a "quiet" process, in hospital, under general anesthesia, and should consist of wedge osteotomy and correction of the valgus, combined with removal of the bursa. Temporary relief of bunion can be given by proper shoes and a curved felt pad taped in place proximally to protect against shoe pressure.

(d) An adventitious bursa sometimes forms on the *plantar* surface of the heel between the skin and a calcaneal spur which is usually located at the inferior tubercle of the os calcis. A sponge rubber pad worn in the shoe under the heel gives relief, or a felt "doughnut" taped in place. Radical cure is by excision of the bursa and spur but is seldom required. Spur and bursa can recur under the same continued irritation.

#### SUMMARY

The causes, diagnosis, types and methods of treatment of bursitis are described in general and the bursal lesions discussed in particular by regions. Conservative office treatment by sponge pressure is emphasized for the uninfected types, and excision advised in chronic or suppurative bursitis. Aspiration, injections and stab drainage are discouraged.





# DISLOCATIONS OF THE KNEE JOINT

WITH SPECIAL REFERENCE TO ACCESSORY AND AFTER TREATMENT

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THE principles which govern the treatment of dislocations of the knee joint and the general prognosis of these injuries have been set forward in various textbooks at some length and particularly in the February, 1939 issue of this Journal in a symposium on reconstructive and plastic surgery in an article by H. Earl Conwell.

From this in general it would appear that dislocations of a remarkable degree are (1) comparatively easy of reduction if they are uncomplicated by a fracture of the adjacent bones; and (2) that the prognosis for a good functional result in the absence of vascular damage is much better than would ordinarily be anticipated.

That reduction of a dislocated knee is not always possible by manipulative means is illustrated by a case recently under the author's observation.

This patient was a 28 year old woman who subluxated her left knee in a fall going downstairs. The accompanying x-ray shows the degree of dislocation. (Fig. 1.) Two attempts at reduction were unsuccessful. On opening the joint six days later it was found that the irreducibility was occasioned by (1) a torn and displaced, internal, semilunar cartilage, and (2) by a transverse tear of the internal lateral ligament. The lower fragment of the torn ligament had been displaced into the joint and wedged between the torn meniscus and internal condyle of the femur. Upon removing these obstructions the dislocation was easily reduced. (Fig. 2.)

The reduction of such a dislocation should always be carried out under general anesthesia with complete muscular relaxation. In this way minimal force can be utilized, thus guarding against further vascular damage should it already have taken place as the result of trauma or

lessening the damage of added injury to the blood supply by the manipulation.

It is agreed by all writers on this subject that following the reduction, the joint should be immobilized for a fairly considerable period of time (six to twelve weeks). Therefore, it becomes doubly important to evacuate the invariable hemarthrosis by aspiration and to repeat the operation if re-accumulation of blood occurs. In addition to making the patient vastly more comfortable this measure will reduce the formation of intra-articular adhesions to a minimum and thus shorten convalescence following the removal of immobilization apparatus.

After the completion of the period of complete immobilization, systematic physiotherapeutic treatment including heat and massage, stimulation and exercise of the quadriceps extensor muscle and manipulations to restore motion should be begun. During this process and for a number of weeks the joint should be protected by a light knee cage or similar knee splint.

That a knee joint which has obviously suffered complete tears of the crucial and lateral ligaments should recover with a surprising degree of stability and function is due largely to the development of a vicarious stability dependent upon the integrity of the quadriceps extensor muscle and its lateral expansions, hence the great importance of devoting considerable attention to the development of this muscle in the convalescent phases of treatment.

Conwell advocates waiting one year before evaluating the end result of dislocations of the knee. If after this period of time the knee remains actively and passively unstable in either the lateral or antero-posterior planes, it is advisable to attempt repair of the anterior cruciate ligament.

The author some years ago reported a series of cases of operative repair of unstable knees by a modification of the Hey-Grooves technic for reconstruction of the

functional result is excellent, but if unsuccessful the alternatives are either permanent brace wearing or an arthrodesing operation on the knee joint.



FIG. 1. X-ray showing a fresh and irreducible subluxation.

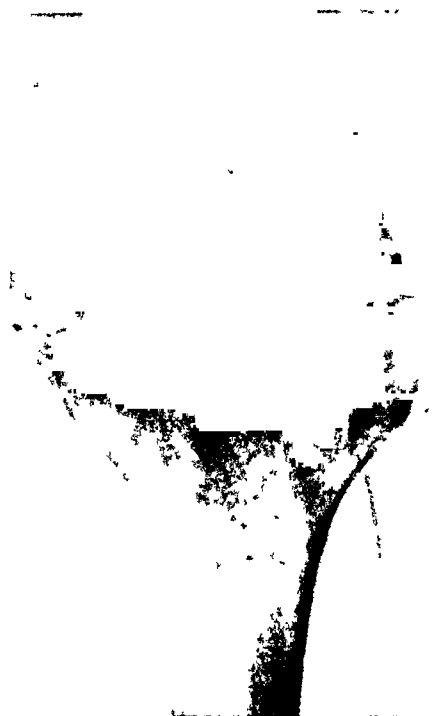


FIG. 2. X-ray following operative reduction.

anterior crucial ligament. Such operative repair has proved successful in the majority of cases. Such an operation either by this technic or the technic of Gallie is indicated in these cases because if successful the

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# EMERGENCY TREATMENT, TRANSPORTATION AND EARLY MANAGEMENT OF FRACTURES\*

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THIS discussion refers to the care of the fracture from the time it is sustained until definite treatment is given, usually in a hospital. It thus includes first aid at the place of the accident, splinting for transportation and the early maneuvers in handling the patient in the hospital, including making the diagnosis, x-ray studies, treatment of compounding, etc. Fractures of shafts of long bones differ from joint fractures and those of small bones. The former have much more tendency to displacement, shortening and avoidable loss of function. Weight-bearing bones take longer to heal and require more perfect reduction and retention to give good function. Above all, the question of infection in compound fractures influences the immediate and subsequent treatment fundamentally.

Although emergency therapy of these injuries is really a part of the definitive management, we shall attempt to discuss it chronologically by taking the patient at the site of the accident and tracing him until the fracture is actually reduced, held and functional restoration begun. These are the cardinal steps in any fracture treatment:

## I. FIRST AID TREATMENT

*A. Prevent Shock.* The degree of shock depends on the circumstances of the accident and associated injuries as well as the treatment received. Shock is minimized by: (1) Maintenance of body heat by warm blankets, hot fluids and prevention of undue exposure in transportation; (2) avoidance of all unnecessary manipulation. If indicated, only the mildest efforts to

correct very gross deformity are permissible before proper x-ray study and anesthesia. (3) Adequate sedation by morphine to relieve pain; and (4) proper splintage before moving the patient. This is of great aid against shock by stopping pain.

*B. Preliminary examination* must be adequate but rapid, and should be made simply to detect gross injuries, deformities, open wounds requiring protection, bleeding requiring control and necessity for splintage. Clothing should be removed only sufficiently to uncover possible wounds in relation to the fracture. In the case of lower extremity injuries above the ankle, the shoes are left on.

*C. Hemorrhage* from compound fractures per se is usually of little consequence unless extensive soft tissue injury has occurred. Tourniquets should rarely be required; direct pressure by sterile gauze and bandage is preferable.

*D. Proper Splintage.* This is a crucial point in early management of fractures of the shafts of long bones. "Splint 'em where they lie" is the rule to be followed. By far the most efficient emergency splint for application in such cases is the Thomas traction arm or leg splint or some modification thereof; the most usual ones are the Murray-Jones or Thomas-Murray arm splint (Fig. 1), and the Keller-Blake half ring army leg splint. (Fig. 2.) Traction is applied manually to the foot (or hand) at first, and then by a hitch or traction strap around the ankle (or wrist). Countertraction is derived from the pelvis (or axilla). The limb is supported by bandages or slings from the side bars of the splint with special care to keep the joints immobile.

\* From the Orthopedic Service of Dr. Arthur Krida at Bellevue Hospital.

All ambulances in New York City municipal hospitals and many other large public hospitals are equipped with such

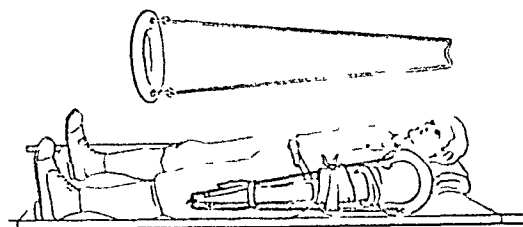


FIG. 1. Thomas-Murray hinged splint, for upper extremity fractures. Note slings to arm, traction on forearm, elbow extended. Whole upper extremity at side of body. (From *Outline of Treatment of Fractures*, by Committee on Treatment of Fractures, American College of Surgeons.)

splints and the materials necessary for their application.

It is a standing rule, impressed on each ambulance surgeon, that suspected long bone fractures must never be moved from the site of the accident without preliminary application of such protection. Such prompt action prevents overriding of the bone fragments due to muscle spasm, needless bruising of soft tissues, compounding of previous simple fractures and shock, by relief of pain while the patient is being moved. Indeed, it is a common finding by x-ray, in fractures of the long bone shafts of the arm or leg, that the original position in the Thomas splint is more perfect than the final one in the retentive apparatus. This is merely due to the greater efficiency of early continuous traction. This lesson was brought home during the first World War, when the simple introduction of the traction splint cut the mortality and end results of compound, long bone fractures tremendously. Every physician should know, by actual trial and training, the technic of proper application of these splints if he treats any fractures at all.

Small bone fractures and joint fractures, in general, do not require more than simple splintage, use of a sling in the upper extremity, and nonweight bearing in the lower extremity during transportation to a hospital. Care, of course, is to be taken

so that undue motion at the fracture does not occur or that jarring does not cause too much pain. Voluntary splintage and

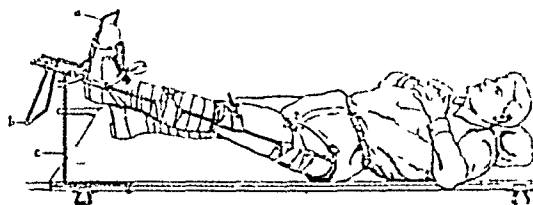


FIG. 2. Keller-Blake hinged half-ring splint for transportation and first treatment of fracture of the leg and thigh. (From *Outline of Treatment of Fractures*, by Committee on Treatment of Fractures, American College of Surgeons.)

support by the uninjured extremities of the patient himself often suffices with simple additional means as above mentioned.

In any severe back injury, the possibility of vertebral compression fracture must be considered. This is especially important where any neurological lesion (paralysis, anesthesia, etc.) is detected. By far the greater number of such vertebral body compressions are sustained in acute flexion by "jack knifing." It is only further flexion which will aggravate the injury or produce spinal cord damage where none was present.

It is vital that patients be not carried by the shoulders and legs all in a heap; this results in further flexion of the trunk. (Fig. 3.) Such patients should be moved with extension of the spine maintained in one of a number of ways. An ambulance is best used to move them. For the cervical region, the patient is placed horizontal, on his back, with a pillow or blanket under his shoulders, so that the neck is hyperextended by the weight of the head hanging backwards. In the lower dorsal and lumbar region, the supporting pillow or blanket roll, etc., should be under the suspected site of fracture, if the patient is to be moved on his back. Preferably, in moving him to the stretcher, he is turned face down and picked up by the shoulders and thighs, so that the trunk is extended. (Fig. 4.) This position is maintained on the stretcher by pillows or blankets under the chest and shoulders and under the lower

pelvis and upper thighs, with the patient on his abdomen, thus continuing hyperextension of the lumbar region. No other

injury, to warrant prompt x-ray study for fracture. In these days of legal complications, insurance coverage, workmen's com-



FIG. 3. If a patient with a thoracolumbar fracture dislocation is carried upward, the spine is forced into flexion and the injury must be increased. (From *Fractures and Other Bone and Joint Injuries*, by R. Watson-Jones, William Wood & Company, 1940.)



FIG. 4. When no stretcher is available, face down transportation is relatively safe. (From *Fractures and Other Bone and Joint Injuries*, by R. Watson-Jones, William Wood & Company, 1940.)

more cumbersome methods of splintage are needed.

## II. MANAGEMENT AT HOSPITAL

The actual detailed treatment will, of course, vary with the individual case. General principles are:

*A. Treatment of Shock.* This includes further maintenance of body heat, removal of clothing without disturbing splintage (still leaving the shoe on in lower extremity cases), sedation with morphine, etc. If not already done, a traction splint is applied as soon as possible before x-raying in cases of long bone fractures. In addition, the shock position in bed, intravenous infusion and, in occasional cases, blood transfusion may be indicated depending on the extent and nature of associated injuries. The average patient with fracture of the shaft of a long bone, in a proper splint, arrives at the hospital in good condition.

*B. Physical Examination.* Definitive diagnosis must now be made and the sites of suspected lesions and proposed x-rays must be determined. Internal visceral, skull and urinary tract injuries must be looked for. It is unwise to attempt to elicit crepitus, false point of motion or other of the gross signs of fracture. It is sufficient to establish local bony pain, swelling or discoloration, related to an

pensation laws and negligence suits, it is foolish to spare x-ray study of suspected bone lesions. Similarly, careful examination for soft part injuries, especially to nerves, tendons and blood vessels, must be made as a routine. In shoulder, humeral and knee fractures especially, nerve injuries must be sought. If a patient falls from a height on his feet, hard enough to fracture his heel, etc., always examine and x-ray the lumbar spine for vertebral compression.

*C. Time Factor.* The sooner reduction of a fracture is done, the easier it will be in general and the less trauma will be inflicted. Fractures requiring manipulative reduction especially, should be treated as soon as possible after entrance to the hospital, e.g., Colles' fracture, displaced ankle fractures, supracondylar humeral fractures, dislocations of all kinds, etc. While it is possible to reduce many of these after lapse of a night or longer, the swelling which supervenes obliterates landmarks and makes final splinting much more difficult even if reduction can be obtained. Long bones may be temporized with if maintained under strong traction in a Thomas splint without strangulation of the foot or hand by the encircling traction hitch. Fracture of the hip may likewise be delayed for a period of a few days in traction to see how the elderly patient will stand confinement in bed and the shock

of injury. Moreover, none of these fractures is so much of an emergency that a shocked patient with other injuries must be rushed through reduction. Rather than put up fractures without x-ray examination, almost any fracture can be deferred from a few hours to a day or so until transportation to a place where the proper two-plane study can be done.

*D. Control of Infection: Compound Fractures.* Tetanus antitoxin should be given in all cases (1500 to 3000 units intramuscularly). This should be repeated in ten to fourteen days if the wound is still a problem and was grossly contaminated. Patients with crushing injuries, extensive bruising and death of soft tissues, comminution of bone, soiling of the wound with street dirt or manure covered country soil, should be given in addition polyvalent, concentrated antigas serum intramuscularly. This will guard against gas bacillus and other anaerobic infections. Proper skin or eye tests for sensitivity to horse serum should always precede administration of these sera.

*E. Decision on Operation.* This should be made as soon as possible. An obviously small wound made by penetration of bone from within or by injury from without, treated early, under relatively clean circumstances, should be cleansed, the surrounding skin carefully shaved and cleansed to spare further contamination, washed with benzine, if necessary, to remove grease, followed by alcohol or ether and iodine and then a dry sterile dressing. The fracture is thereafter treated exactly as though it were a simple fracture. The skin of such punctured wounds should never be sutured. Small stab and gunshot wounds must be judged by the particular indications in the particular case. If it is difficult to determine connection of a small wound with bone, the presence of fat globules mixed with blood is in favor of a bony injury.

All other compound fractures demand surgical intervention as soon as possible, but never before recovery from the initial

shock. These injuries may be classified as (Bohler): (1) Contaminated cases, those seen within four to six hours from the time of the injury, or in selected cases, up to twelve hours. (2) Infected cases, including all cases seen longer than twelve hours and usually longer than four to eight hours after the accident, as well as certain cases seen even earlier, and of course all cases with frank suppuration, gas infection, etc., already in evidence.

Detailed care of all types of compound fractures cannot be given in the brief space of this article. Certain principles only may be stated regarding their management. The limb is prepared in the splint so far as possible, avoiding further wound contamination in shaving, cleansing or too strong preliminary irrigation. The remainder of the preparation is done after anesthesia has been induced. Anesthesia is frequently local, infiltrating the area at a distance from the skin edges all around and underneath the wound and at the fracture site; many cases, of course, demand regional or general anesthesia.

Attempt is then made to excise completely all infected tissue, preserving as much skin as possible and paying especial attention to the skin edges, bruised and shredded fascia, muscle and soiled bone. Frequent changes of gloves and instruments are made as needed on proceeding into the wound depths. Thin, wide surfaces of muscle and actually contaminated bone edges, with perhaps  $\frac{1}{2}$  to 1 mm. of contused skin edge, are usually removed. Loose pieces of bone should never be discarded unless completely free of periosteum, fascia and muscle, as union may be jeopardized if too much is removed. After complete excision of the early, potentially infected cases, the skin is closed without drainage and with no deep sutures, except for possible nerve or arterial sutures. In the infected cases or those in which trauma was so extensive as to contraindicate such closure, the excised wound is packed wide open with vaseline gauze (Orr treatment) or iodoform gauze, or it is

Dakinized from the first. It is at this stage that 5 to 15 Gm. of sulfanilamide crystals (Jensen et al) may be placed in the wound to counteract invasion of streptococci and some other invading organisms including gas bacilli. This may be introduced into wounds which are to be closed or left open. According to Key and others, wound healing is unimpaired and infection is prevented. This form of therapy is still under investigation and is too recent to be used routinely.

No attempt is made to expose the bones extensively enough to perform internal reduction and fixation. Rather, after thorough debridement as has been described, the fracture is reduced as a closed fracture by manipulation or appropriate skeletal traction with application of a nonpadded plaster cast for more perfect immobilization wherever possible. Windows are cut in the cast only when fear of infection or constitutional reaction demand it.

*F. Prophylactic Use of Sulfanilamide.* In this form of treatment, moderate doses of sulfanilamide are given orally as a possible preventive of extensive infection in all sorts of traumatic wounds. This is receiving an extensive trial in the present war, especially in Great Britain (Whitby) but its efficacy has not been accurately determined. It would appear useful against the hemolytic streptococcus and gas bacillus but not against *Staphylococcus aureus*. Administration of this drug must be controlled by frequent clinical, blood and urine examinations to detect complications.

*G. Definitive treatment* is then undertaken as soon as feasible. Here, it must be emphasized that the patient must not be lost sight of in treating the fracture. Visceral injuries, chest complications or intracranial injuries may render fracture

treatment of secondary importance. Primary operative treatment of simple fractures is often required in displaced fractures of the olecranon, patella, head of the radius, condylar fractures of the knee and elbow, cases in which a loose fragment prevents proper reduction or in which closed reduction allows too much persistent displacement with its promise of future deformity. Under favorable and aseptic operating conditions, with the modern use of vitallium materials for osteosynthesis, numerous fractures of both bones of the forearm, oblique fractures of tibia and fibula, intracapsular hip fractures, femoral shaft fractures and others are being treated by open reduction more often, as a matter of choice.

The final point to be emphasized is the medical and medicolegal necessity for postoperative and check-up x-ray studies. The need for these is obvious, but they are all too often neglected, with the result that negligence suits are not only started (which is sometimes unavoidable) but won. Every displaced or potentially displaced fracture should have an x-ray examination before attempt at reduction, immediately afterward to check reduction and at appropriate intervals thereafter.

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# DISLOCATION OF THE SHOULDER

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THE correct handling of shoulder dislocations is of prime importance to the general practitioner. Usually he is the first to come in contact with this injury no matter whether he is situated in a small community or in a large metropolis. The proper recognition of this condition and its early reduction should not offer difficulty in general, but it is essential that the limitations of various methods of treatment in individual hands be kept in mind. Only by having adequate knowledge of the mechanics of the causative accident, of the pathology and of the relation of the important structures surrounding the injured joint may an excellent end result be obtained. Besides restoring the normal anatomic constitution of the joint without unduly traumatizing important structures, one must anticipate the prevention of recurrent dislocation which is a serious disability.

The patient may give the story of a heavy fall on the shoulder, on the outstretched arm or on the elbow. However, a strong pulling force exerted on the shoulder may be the causative factor. The dislocation usually occurs with the extremity in a position of moderate abduction and some degree of rotation. A fall on the arm would thus pry the head of the humerus out of the glenoid and through the weakest point of the capsule at its anterior inferior portion. It is here between the long head of the triceps posteriorly and the subscapularis anteriorly that the capsule is least protected by musculature. This factor also determines the frequency of anterior or subcoracoid dislocation as contrasted with the rarity of posterior dislocation.<sup>20</sup> Although most observers believe that the injury is caused by a leverage action on the humerus, it is also likely that direct trauma to the humeral head or along the

shaft of the humerus will thrust the proximal end of this bone out of the glenoid.<sup>1</sup> This may be accomplished by a fall backward on the shoulder or on the tip of the posteriorly displaced elbow. Strong muscular action may be a definite factor in sliding the head of the humerus over the glenoid rim. Undoubtedly, dislocation caused by this latter mechanism can be produced only when there is a pre-existing defect of the shoulder either congenital or acquired. A shallow or partially deficient glenoid,<sup>20</sup> large or misshaped humeral head, relaxed capsule and muscular imbalance are all predisposing factors for dislocation.

Thus primary dislocation of the shoulder is caused by a more or less severe trauma and is accompanied by very characteristic and well known signs and symptoms. Severe pain and restriction of motion, flattening of the shoulder, apparent lengthening of the arm, flexion and internal rotation of the arm, inability to press the arm close to the side and prominence of the humeral head in the axilla are all indicative of this condition when all or a majority are observed. However, the examination is not complete unless an attempt is made to rule out motor or sensory changes as well as circulatory damage in the affected extremity. Various degrees of anesthesia or paralysis of the extremity may have been caused by tear or rupture of the brachial plexus or its peripheral branches at the time of the accident. Blood vessel injury may be a serious complication and the palpation of the radial pulse is a simple though efficient method of indicating the adequacy of the blood supply. In all cases it is extremely important to note these latter findings before an attempt is made at reduction. Fractures about the shoulder may be associated with dislocation in .5 to



22 per cent of the cases.<sup>15,19</sup> These may be avulsions of the tuberosities, fracture of the glenoid of the scapula or fracture of the neck of the humerus. They occur most often in individuals over 40 years of age and their coexistence definitely alters the prognosis.<sup>5,12</sup> Stereoscopic or anteroposterior and lateral x-rays of the shoulder are of value not only in establishing the diagnosis and ruling out fracture but also in helping to outline the course of treatment.

#### REDUCTION

Early reduction is essential here as in other dislocations. In very fresh cases seen within fifteen to thirty minutes following the accident, it may be possible to reposit the humeral head by gentle manipulation or traction and axillary pressure without anesthesia. However, it is safer to apply a temporary sling and to hospitalize the patient so that x-rays may be taken and the reduction accomplished under narcosis. The method of choice for reduction should depend on the experience of the operator. Nevertheless all methods are not infallible and several may have to be tried in order to succeed. The various maneuvers described in the literature depend on either leverage action, traction or their combination to replace the head of the humerus into the glenoid. Probably the Kocher method is the best known but the classical Hippocratic maneuver of traction and countertraction in some form, has been the one most extensively used. Even in the most expert hands these methods are not without failure and may be productive of serious trauma to axillary blood vessels and nerves. During recent years several maneuvers have been described which according to the authors are less traumatizing and very effective. Peterson<sup>19</sup> favors Zierold's method of controlled leverage in which the operator places his elbow in the patient's axilla and with the same hand holds the patient's forearm above the elbow. Thus traction can be applied while the arm is gradually abducted. Milch<sup>14</sup> employs gentle abduction and external rotation while holding

the head of the humerus in the axilla so that it does not slip lower. He states that it is very efficient even with no anesthesia. Shumate<sup>21</sup> exerts traction on the affected extremity by means of a sling around the operator's back and shoulder and the patient's elbow. Pressure is applied against the side of the patient's chest while the surgeon's thumbs push up the head of the humerus. The older methods should not be discarded but the various other maneuvers should be kept in mind in case one fails. In all cases gentleness in the attempt at reduction will obviate undue and sometimes regretful complications. Persistent failure in reducing a given dislocation, especially one not seen early, warrants seeking expert assistance. Definite fibrosis and contracture may occur within two to three weeks making closed reduction difficult if not impossible.<sup>2</sup>

After having attained an appropriate reduction, retention of the extremity in a position most conducive to healing is an important part of the treatment. The injury must cause a joint relaxation whether by stretching or tear of the anterior portion of the capsule or by rupture of the anterior glenoid ligament. Immobilization by strapping the arm to the side in an attitude of adduction and internal rotation or in a Velpeau bandage must be sufficiently long to allow healing of the damaged capsule. Three weeks is not too long a period for this purpose. The importance of avoiding permanent relaxation of the capsule cannot be stressed too greatly in the prevention of recurrent dislocation. Active motion and exercises are then instituted to strengthen the shoulder musculature. Heat in its various forms will undoubtedly add to the patient's comfort and ease his attempted motions. Abduction should probably be restricted for several weeks but one will find that nature has already taken this safeguard as deltoid power is weakened and there may exist some moderate shoulder fibrosis. Circumduction of the arm, while the trunk is bent forward first without weight and later with the patient swinging two pounds,

is of value in restoring motion. Still later finger creeping up the wall with the extremity in abduction as well as pressing the hand sideways against the wall will improve deltoid function. It may be advisable to warn the patient to avoid strenuous use of the arm for a period of time but following proper care and the return of strong muscle power most patients may resume fairly active labor within six to eight weeks. In complicated dislocations the recovery period will naturally be of longer duration depending on the additional trauma. Fractures should be treated preferably by closed methods as the functional end result is usually better.<sup>11</sup> Fracture dislocations of the head of the humerus in older persons may require excision of the head of the humerus in order to avoid prolonged immobilization and yield a fairly well functioning shoulder devoid of pain. Aseptic necrosis of the head is occasionally seen in these cases and also may require excision.<sup>12</sup> Nerve injury may entail months of treatment for complete or even partial recovery.<sup>13</sup>

In old dislocations when closed reduction has failed, Bennett<sup>2</sup> advises open reposition of the head into the cleared glenoid fossa followed by a biceps tendon suspension and repair of the capsule. He reports satisfactory results from this procedure but believes that older individuals should be given conservative therapy especially if they regain 50 per cent of painless, free motion.

#### RECURRENCES

From a review of the literature it is apparently difficult to ascertain the percentage of recurrent dislocation of the shoulder following a primary injury. According to Henderson habitual dislocation which is a most disabling condition is rare.<sup>7</sup> In most cases the etiologic factor is severe trauma at the time of the first dislocation. The usual history also shows that the period of immobilization following reduction was either lacking or too short. Dislocations may recur infrequently following lesser grades of trauma or may be habitual and occur practically at the

will of the patient. The shoulder may be dislocated when the patient moves about in bed in his sleep or in epileptics during a convulsion. As many as 100 consecutive dislocations have been recorded in an individual.<sup>8</sup> The recognized pathology is a weakness of the anterior inferior part of the capsule due to failure of healing of the original tear. Bankart believes that the head of the humerus shears off the fibrous or fibrocartilaginous glenoid ligament from its attachment to the bone and that there is no tendency whatsoever for healing.<sup>1</sup>

Kellogg Speed quoted by Codman<sup>3</sup> outlines the following causes of recurrent dislocation: (1) Defect in the head of the humerus acquired at the first dislocation or perhaps congenital; (2) shallowness of the glenoid following fracture or congenital; (3) rupture of the insertions of the external rotators of the head of the humerus; (4) avulsion of the tuberosities with or without rupture of the rotators; (5) detachment of the capsule from the anterior glenoid; (6) enlarged joint from a relaxed capsule following tears which have been given insufficient time for strong cicatrization or repeated stretching without tears; and (7) (Codman) incoordinated muscle pull from two opposing muscles.

Prevention of this condition is of importance in the treatment of primary dislocation as has been described. However, once it has occurred its control may be accomplished by conservative methods or by operative reconstruction. Codman<sup>3</sup> usually advises the patient to limit his activities and change his occupation. Davis believes in developing the shoulder musculature as well as aiding in the healing of the capsule in early cases.<sup>4</sup> Many operations have been devised for the correction of this condition. Each attempts to remedy an outstanding defect as listed in the aforementioned causes. Some try to deepen the glenoid (Hildebrand) by inserting a bone graft in its margin (Speed). Albee and MacAuslan repair the capsular relaxation while Gallie<sup>6</sup> makes a new inferior glenohumeral ligament with fascia lata. Hey Groves constructs a fascial sling under the

capsule and attaches it to the acromion above.<sup>9</sup> The Clairmont procedure depends on strengthening the capsular defect by the transference of a section of deltoid muscle as a sling across the weakened portion. Henderson uses a part of the tendon of the peroneus longus to suspend the head of the humerus to the acromion with excellent results.<sup>7</sup> Hobart advises the combination of the Clairmont and the Nicola operations.<sup>10</sup> Nicola has devised an operation which is fairly simple to perform and has been successful both for control of the disability and for return of good function not only in the hands of its originator but in general use, especially throughout this country. The tendon of the long head of the biceps brachii is passed through a tunnel gouged in the head of the humerus and resutured to itself in order to suspend the humerus. The head of the humerus is thus actually attached to the glenoid by a newly formed, stout ligament and cannot slip out of the joint.<sup>17,18</sup> Other advantages of this procedure with which we have had some experience are that active motion may be begun in three weeks and that this procedure is indicated no matter what defect is causing recurrence of dislocation.<sup>16</sup> Nicola reports practically no restriction of motion and no recurrences in thirty-two of his patients after a follow-up of several years.<sup>17</sup>

#### SUMMARY

1. Early recognition and treatment of shoulder dislocations is essential.

2. A knowledge of the mechanism of the accident and of the pathology is of value in the treatment of these cases.

3. Fractures and blood vessel and nerve injuries should be searched for before attempting reduction.

4. Adequate protection after reduction is necessary to facilitate healing of the damaged capsule. This will help prevent recurrent dislocation.

5. Several operations are advocated for control of habitual dislocation.

6. The Nicola operation seems to enjoy general use and approval in this country. It can be performed by the average surgeon and if done correctly will yield excellent results.

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# TRAUMATIC DISLOCATIONS OF THE HIP JOINT\*

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**T**RAUMATIC dislocations of the hip joint comprise a very small percentage of all dislocations. These are estimated at from 2 to 5 per cent by different authors. The incidence has increased in recent years because of severe trauma sustained in automobile accidents, hence the term "dash board dislocation." In these cases the most common cause of dislocation is a severe blow on the flexed knee against the rear seat or dash of the car while the patient is sitting with hips flexed. The force transmitted from the knee to the hip forces the femoral head from the acetabulum, usually in a backward direction.

Dislocations are classified as anterior or posterior, in regard to their relation to Nelaton's line which bisects the acetabulum, and furthermore, as high or low depending on the final resting place of the dislocated head. Posterior positions are seven times more frequent than anterior positions. This is due (1) to the weaker posterior hip capsule, (2) to the fact that the most frequent force applied is to the hip in a flexed position and in a backward direction, and (3) to the stability of the hip which is at its minimum when in this flexed position. Any trauma which approximates the knee and pelvis may produce a posterior dislocation. Anterior dislocations usually result from forceful abduction with or without external rotation. In these motions the head is pried from within the acetabulum and is forced through the capsule anteriorly.

In all dislocations, whether anterior or posterior, there is usually considerable shock in view of the trauma to the soft parts and the frequency of fracture of the acetabular rim. The ligamentum teres is always torn and also the capsule. When

the head passes through the capsule posteriorly, there is injury to the short external rotators and the sciatic nerve may be traumatized. When the head comes forward through the anterior capsule, the adductors and obturator internus muscle are prone to injury.

## DIAGNOSIS

The diagnosis of a posterior dislocation is based on the following findings: With a history of recent severe injury the patient presents an acutely painful hip on which he is unable to bear weight. The characteristic position is that of flexion, adduction and internal rotation. This position is relatively fixed and cannot be altered actively. The extremity is shortened, though the apparent shortening is greater than the real shortening. The tip of the great trochanter is above Nelaton's line and the buttock on the affected side is prominent due to the presence of the dislocated head beneath the glutei. Although motion is markedly restricted, it may be possible to move the hip in the direction of the existing deformity, that is, in flexion, adduction and internal rotation. External rotation, abduction and extension are impossible because of the tense Y ligament on the anterior aspect of the joint. This ligament is very rarely torn and then the limb will fall into an everted position rather than remain in internal rotation. The high type is much more common than the low. Except for the fact that in the low type there is a greater degree of flexion deformity present, the above is applicable in diagnosing both types.

Diagnostic signs of an anterior dislocation are quite the opposite from those of the posterior type. There is usually a

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history of a forceful spreading apart of the lower extremities. The involved extremity is maintained in external rotation

be palpated in Scarpa's triangle or in the adductor region. Goetz has reported a case in which the head came to rest within the



FIG. 1. Low anterior dislocation in 23 year old male.

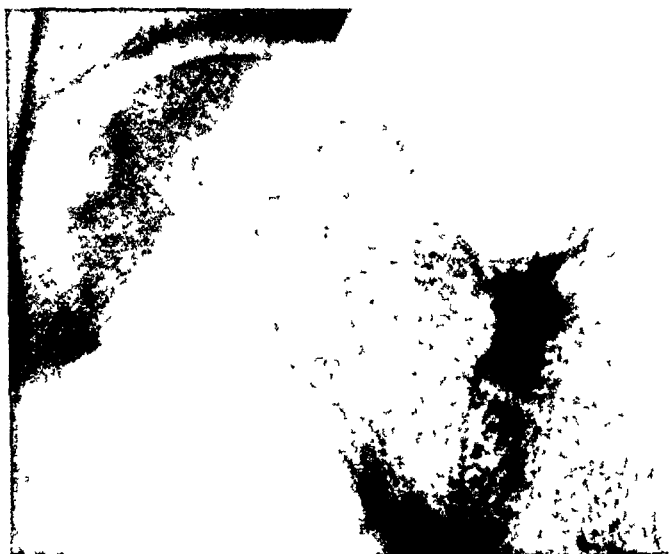


FIG. 2. One month after reduction. Note early necrosis of head at central portion, wedge-shaped area of destruction.

and abduction. There may be slight flexion or extension. The trochanter is depressed and the lateral aspect of the hip is flattened. The head of the femur may

scrotum. In this case the abduction deformity was beyond 90 degrees and there was marked internal rotation, probably because the head had passed below the

pubis and had no support. The high type of anterior dislocation is more common than the low. Usually the lower the head

to about 90 degrees in order to relax the Y ligament and to bring the head opposite the tear in the capsule is an essential point.

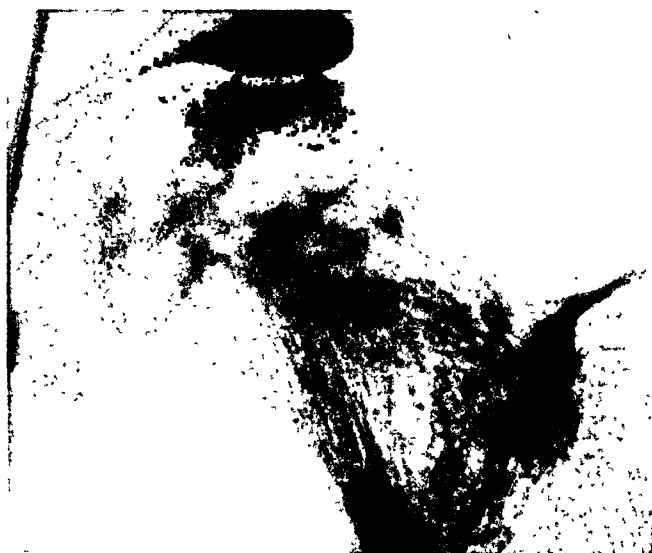


FIG. 3. After two years. Flattened head; narrowed joint space; areas of increased density surrounding areas of decreased density.

is displaced the greater is the abduction deformity. In all cases there is some actual shortening, but because of the abduction deformity there is apparent lengthening of the limb. Internal rotation and adduction are markedly limited or absent, whereas external rotation and abduction may be increased.

#### TREATMENT

Returning the dislocated head into the acetabulum and maintaining it there is the primary consideration in treatment. Since delay renders reduction more difficult, it should be done as soon as possible. Because of the powerful musculature about the hip a general anesthetic is essential to secure relaxation.

During any manipulative procedure it should be kept in mind that the sole object is to return the head to its socket along the path it traveled while dislocating and to do this with the least possible trauma to the badly injured soft parts. It must be disengaged from these soft parts and returned to the acetabulum through the original tear in the capsule. In all methods of reduction, flexion of the thigh

In posterior dislocations there are three methods of reduction in common use, namely, Allis', Bigelow's and Stimson's.

Allis' method is primarily that of traction and countertraction of the flexed thigh against the pelvis. The patient is placed on the floor, the pelvis held down firmly by pressure over the iliac crests by an assistant or by a strap; the thigh and leg are flexed at right angles and then strong, continuous traction is made on the thigh grasped just above the knee. Bohler modifies this method by using a towel applied around the thigh, above the knee and then tied around the operator's neck. From a kneeling position the operator exerts a strong upward pull by straightening his back. At the same time downward pressure is exerted on the foot in order to produce leverage over the surgeon's knee which is placed in the popliteal region of the patient. Bohler reports complete success with this method in all types of dislocations. If resistance is encountered in using this method gentle manipulation to disengage the head should be carried out. Adduction and internal rotation should be increased.

The method of Bigelow is more fraught with danger of injury to soft tissues inasmuch as it is essentially manipulative

tained, the thigh is gently adducted and internally rotated to bring the head over the rim and into the acetabulum. As has



FIG. 4. Flattening of head increased. Shows necessity for long period of nonweight-bearing.

in character. The pelvis is immobilized and the thigh is rotated internally, adducted and flexed on the abdomen. In this position traction is exerted on the thigh in an upward direction and then the limb is slowly circumducted, that is, swept out into abduction and then into extension. As it is abducted, it is externally rotated. The first maneuver relaxes the Y ligament and brings the head down to the level of the tear in the capsule. In this position traction pulls the head up on the posterior rim of the acetabulum; then abduction and external rotation pry it forward into the acetabulum.

The Stimson method is probably the least traumatizing. The patient is placed on the table in the prone position projecting over the end and allowing the affected thigh to hang down. The other thigh is supported by an assistant. In this position gentle downward traction with slight rotation and rocking will usually effect reduction.

The rarer anterior dislocations are reduced by Allis' method as follows: The thigh is flexed slightly and the abduction deformity and external rotation are increased. Then direct traction is exerted on the thigh. These maneuvers lift the head away from the pelvis. With traction main-

tained, Bohler uses traction satisfactorily on the thigh flexed to 90 degrees in all types of dislocations.

The treatment of reduced cases is at first concerned with prevention of recurrence. Those of the posterior type must be protected against flexion and adduction; those of the anterior type against abduction and external rotation. Bed rest from three to six weeks with or without plaster immobilization is usually recommended. Then weight bearing with the use of crutches is allowed.

Although most textbooks fail to mention aseptic necrosis of the femoral head as a sequela of traumatic dislocation, its importance and frequent occurrence has been noted within recent years. Bergmann, in 1931, was one of the first to note and report such a case. Stewart, in 1933, reported the first case in America. Funsten, Kinser and Frankel in reviewing twenty cases of dislocation in 1938 noted necrotic changes in the head in the follow-up of six cases. This report emphasizes the frequent occurrence of these late changes which in the past were undoubtedly considered as traumatic arthritis.

In 1939, Potts and Oblatz reported five cases and Kleinberg two. Phemister, and Chandler and Kreuzer have also reported

such cases. At Bellevue Hospital, we have operated upon one patient who presented a typical case. In view of the relative infrequency of hip dislocations, the number of reported cases of aseptic necrosis of the head signifies that its occurrence is not infrequent.

Necrosis of the head following dislocation is due to a loss of blood supply to a part or all of the head. The blood supply of the head is derived from vessels in the neck, the ligamentum teres and the capsule. Tearing of the capsule and rupture of the ligament deprive the head of a great part of its circulation and the extent of the necrosis depends upon the degree of loss of blood supply. Because of this, Phemister and Kleinberg have cautioned regarding manipulation. Gentleness in reduction lessens damage to injured vessels and thereby lessens the possibility of aseptic necrosis. They have also emphasized the importance of protection of dislocated hips from weight bearing for long periods in order to allow revascularization of necrotic areas and the replacement of necrotic bone by new bone (creeping substitution). The anticipated flattened deformity is thereby reduced to a minimum or prevented. Kleinberg advises the wearing of a long Thomas walking caliper brace for one year.

The clinical symptoms of necrosis are pain and stiffness of the joint coming on a few months after reduction. These symptoms increase, a limp becomes noticeable and a flexion adduction deformity develops. No appreciable actual shortening is present.

Other sequelae are (1) myositis ossificans of the torn capsule, which may cause pain and stiffness of the joint and necessitate operative treatment, and (2) persistent nerve injuries. Muscle injuries do not demand special care and cause no sequelae. Fractures of the acetabular rim may demand operative treatment at the time of dislocation or at a later date. Fragments

causing limitation of motion should be removed.<sup>\*</sup>

#### SUMMARY

1. The incidence, classification, mechanics of production, diagnosis and methods of reduction of traumatic dislocations of the hip have been reviewed.

2. The occurrence and frequency of aseptic necrosis of the femoral head after reduction has been emphasized.

3. Protection from weight bearing by means of a brace for a long period to permit substitution of necrotic bone by new bone and the prevention of deformity of the head are essential.

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\* The illustrations are x-rays of a case reported in an article by Axhausen and Bergmann in 1937 and are presented by courtesy of the latter.



# THE USE OF PLASTER

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A PLASTER of paris dressing applied to a limb or portion of the body which does not function other than to cover the part is entirely without virtue as a surgical appliance. On the other hand, there is no satisfactory all around substitute for this material for the execution of splintage problems, small or large, simple or complex.

Think of the newborn infant who for the first months must have properly applied forces to correct the resistant deformity of a club foot, and that these forces are applied continuously and progressively up to the pressure tolerance of the delicate skin and underlying soft parts.

Think of the 200 pound adult who must have one or both lower extremities immobilized and anchored to his trunk for several months. Both of these problems can be solved best by the use of plaster of paris. In order to prevent delay and skin damage in the infant, and to assure comparative comfort and lasting efficiency in the 200 pound adult, not only the application of the appropriate size and number of bandages, but their application with proper care and thoughtfulness are absolute requisites.

Plaster of paris has been widely used as a splintage material since Matthysen, a Dutch Army Medical Officer, published a pamphlet on its uses in the treatment of fractures in 1852.

For the average user, plaster of paris bandages are available in the usual sizes—2, 3, 4 and 6 inch widths—and in various setting times—slow, fast and specially fast. These bandages are prepared by several well known manufacturers and are of dependable standards. They come boxed in moisture proof containers and should be stored without altering this factor.

For frequent users, home made bandages are less expensive but care and experience are necessary to produce good ones. The cloth portion (crinoline) of the bandage is of a stiff meshed material, sized with a substance which will not interfere with proper setting and drying of the plaster of paris. The mesh should be of sufficient size to permit plenty of plaster to be rubbed into its surfaces. Two meshes of crinoline are available for use; the best 32 by 28 mesh, and the next best 28 by 24 mesh. The latter is less expensive but makes satisfactory bandages. The plaster portion of the bandage is of the finest grade plaster of paris known usually as "dental," "surgical," or "orthopedic" plaster and comes packed in 100 pound moisture resistant bags or in 250 pound barrels. These containers give adequate protection from moisture, if stored in a dry place, for eight to twelve months. In making the bandages the crinoline is torn into strips of the desired width and cut into proper lengths—2 inches by 3 yards, 3 inches by 3 yards, and 4 and 6 inches by 5 yards.

The plaster is rubbed thoroughly into the meshes of the crinoline and the bandage rolled firmly but not tightly. Care in handling so as not to dislodge the plaster obtains at all times and is more to the point than wrapping each bandage in paper for this purpose. Straight splints can be made and stored as such by reversing a given length of bandage on itself a number of times.

Immersing the bandages at the time of their use is of the utmost importance. A sizable container of water is necessary (12 quart pail). Changing to fresh water as plaster saturation takes place is absolutely essential. Agents in the water to accelerate drying, such as salt or sugar, are unneces-

sary. Bandages are gently placed on end in the water about one minute before the surgeon is ready for it. After the bubbles have ceased to rise, indicating wetting of all layers, the bandage is grasped with both hands; the palm of each hand is held firmly against the ends of the roll. When free of the water, the roll is squeezed with a twisting motion, then straightened or untwisted with the palm of the hand held firmly against the ends. At this stage the bandage should not be wet enough to drip.

In the application of a large plaster dressing, such as a jacket or spica, it is important not to permit too much drying between layers, so that the entire thickness is one of amalgamated strength and not several layers of dry cleavage planes between.

Strength results with proper application and rubbing of each turn into the previous one. Lightness also results because less material is needed.

#### PREPARATION OF THE PART FOR APPLICATION OF THE PLASTER

Proper application of the under dressing is of no less importance than the outer shell of gypsum. An excellent covering for the skin, form fitting and easily applied, is a stretchable cotton material called stockinette. It is knit as a circular tube and comes in diameters of 3, 6 and 11 inches so that a piece of appropriate length can be cut and pulled over the part to be encased with the bandage. Several inches of extra length are left to be pulled back over the ends of the cast and anchored with the last turn or two of the plaster bandage. This makes a neatly finished end and helps prevent irritation of the skin.

*Sheet wadding* is a thin sheeting of non-absorbent cotton with a thin, hard finish of starch. It is sold in 36 inch widths 6 yards long. From this bandage rolls of different widths are made. These rolls should be not greater in diameter than can be easily held in the hand. Large thick rolls are cumbersome and difficult to apply. The number of layers one uses for padding

varies with the cast at hand and the part to be padded. In general two layers of sheet wadding make sufficient padding, but over the heel, sacrum and the anterior bony prominences of the pelvis several additional layers are necessary. A number of extra turns about the lower thorax, when encasing the trunk as part of a body spica, are absolutely essential for the patient's comfort. In applying a body jacket a square pad of four to six layers over the epigastrium will be appreciated by the patient at mealtime, as this pad can be removed after drying of the jacket, and thus allow for expansion of the abdomen.

*Felt.* White or gray felt about one-fourth inch thick and weighing slightly over two pounds per square yard, is a serviceable stock material to use as additional padding. It is extremely useful in very thin or elderly subjects in whom bony prominences demand the greatest consideration. In the aged, pressure necrosis will occur over night without proper padding.

*Casts.* These are built by circular bandaging of the properly padded part. The bandages are applied smoothly; each turn is pulled firmly but without constriction or roping of the bandage. Each turn is rubbed into the one beneath and support, if needed beneath the part being bandaged, is supplied by the palm of the hand instead of the fingers, which leave indentations. The attitude or desired position of a limb is obtained before any dressings are applied and is then maintained throughout the application of the padding and the overcoating of plaster, so that no wrinkles are formed by changing the position during the setting process. With experience one learns to utilize the small, final molding possibilities during the setting period.

Nonpadded casts or semipadded casts (over thin flannel bandages) are very useful for light weight, efficient splinting of certain joints, such as the wrist and knee. Their routine use in acute fractures should be left to those thoroughly trained in their application.

*Splints.* Plaster of paris lends itself admirably to custom or tailored splints. There are two very satisfactory ways of making these: (1) Applying a lightly padded, circular bandage, which after drying twenty-four to forty-eight hours can be bivalved and the best suited half retained as a splint. (2) Molding to the anterior or posterior surface of the part to be splinted, a plaster reverse of appropriate size and thickness by a circular, flannel bandage. After setting ten to twenty minutes remove the bandage as a mold and allow it to dry over night. It can then be bandaged on in the regular way and removed as often as the case demands.

*Reinforcement Splints.* Often the incorporation of a plaster reverse in the outer layers of a regular or compression bandage will be very helpful for immobilization where surgical or bulky dressings are necessary.

*Emergency Splints.* The specially fast setting plaster makes an excellent temporary splint for transportation of fractures or dislocations. Here reverses are applied to the available or exposed surface of the part and held in place by circular flannel or gauze bandages. Setting takes place rapidly and after a short period of drying

the patient can be moved with comfort and safety.

*Jackets and Corsets.* For support of the trunk alone, or as the foundation of a support to the head and neck, a plaster jacket properly applied has no equal. A removable corset can be made by splitting the jacket down the front immediately after setting, springing it off and after thorough drying it can be covered with stockinette and hooks and lacing sewn to each edge of the split front.

#### IMPRESSIONS AND CASTINGS OF POSITIVE REPRODUCTIONS

In the construction of certain more permanent types of form-fitting appliances of metal, celluloid and leather, there is no better model than the positive reproduction in casting plaster of the limb or trunk in question. A satisfactory impression or mold can be made of the part by using fast setting plaster of paris bandages, which then are removed, reassembled for proper contours, and filled with casting plaster. This model then serves the brace maker with an accurate reproduction of the part.

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# PARONYCHIA AND BONE FELON\*

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**P**ARONYCHIA or "run around," as it is frequently called by the laity, is the most common infection involving the hand. This infection presents many varied manifestations, for the clinical appearance is determined by the duration and severity of the infection. It is commonly initiated by the occurrence of an infection in a so-called hangnail or a split in the eponychium. Any infected hangnail to all intents and purposes is a paronychia; however, many hangnail infections subside without giving rise to the cardinal signs of a paronychial infection. An acute infection may occur on the side of a nail with early formation of abscess with or without evidence of a hangnail. (Fig. 1a.) If this process continues unabated, the base of the nail becomes involved and characteristic redness and rounded swelling appear. In this early acute stage the pain is severe, but it subsides with drainage of the abscess which in turn results in the subsidence of the inflammatory process. Again, a seemingly associated acute infection of the side of the nail and a true infection of the base may arise simultaneously. The prognosis in this latter type of infection is not as good as in infections of the side of the nail treated early; however, if localization with formation of an abscess occurs in the involved side the general involvement of the finger subsides gradually.

There is still another type of paronychial infection, an indolent form, which may be the residual of the acute infection at the side of the nail or the condition may be indolent from the time of its inception with or without evidence of an infection at the side of the nail. In this group of infections, which are usually easily recog-

nized, the period of healing may cover several weeks. There is swelling and redness at the base of the nail with little or no associated pain. During the course of the indolent infection a small amount of drainage gradually occurs which may be expressed by pressure on the eponychium.

In time, the nail root becomes yellowish and free from its attachment. At this stage an abundance of granulation tissue resulting from proliferation of the radix may appear. (Fig. 1b.)

In the treatment of paronychial infections, no set procedure can be established. The treatment depends on the extent of the infection and the stage of the involvement. For infection on the side of the nail warm, moist packs preferably of a 50 per cent solution of alcohol should be employed in an attempt to produce localization of the infection. When available, roentgen therapy is believed to be of definite benefit. When abscess occurs, drainage is best established by complete removal of the necrotic skin which forms the dome of the abscess; this procedure prevents the infolding of the edges of the skin which is a barrier to drainage. This type of infection usually is self-limited and runs its course over a period of a few days. If the infection should extend to the base of the nail, the process may be benefited by gently pushing back the eponychium and applying a 10 per cent solution of silver nitrate. The process may then subside without drainage and its course gradually terminate. Roentgen therapy is found to be of value, particularly if used in the early stage of the infection. If the condition becomes chronic and pus is found under the overhanging edge of the nail and the nail root becomes elevated, the establishment of

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drainage becomes necessary. This may be done by gently pressing back the eponychium and removing a portion of the over-

should consist of elevation and the application of warm, moist dressings preferably moistened with a 50 per cent solution of alcohol. When the acute process has subsided, light treatments should be employed several hours daily to promote absorption and lessening of the edema.

#### BONE FELON

"Bone felon" is the term employed to denote an osteomyelitis of the terminal phalanx of a finger. The occurrence of bone felons may be attributed to the anatomic construction of the soft tissue over the distal phalanx, in that the connective tissue framework produces a closed space. Kanavel called attention to the fact that the blood vessels run parallel to the phalanx on both sides through these closed spaces. With the occurrence of an infection avenues of escape are lacking and the edema and inflammatory process produce circulatory embarrassment with resulting bony necrosis. The epiphysis of children receives its blood supply before the vessels enter the closed space and it is therefore uninvolved in the primary process and usually remains intact.

At the onset of bone felon a sticking, sharp pain appears in the distal phalanx; this usually follows a puncture wound or trauma but occasionally a cause cannot be elicited. The process increases rapidly, and swelling, heat, localized tenderness and excruciating pain are produced. The pain is constant, boring in character, and at times difficult to relieve even with morphine. The systemic reaction usually is mild although there may be slight to moderate elevation of the temperature. The edema present produces a tenseness of the distal phalanx with drum-like stretching of the skin and associated pallor. On close inspection a central bluish portion frequently may be seen which is the result of deep hemorrhage and necrosis. If allowed to progress, the tenseness is soon replaced by a board-like hardness and in time by fluctuation with necrosis of the tissue and frank formation of pus. When destruction



FIG. 1. Appearance of infection: *a*, acute infection at the side of the nail; *b*, chronic paronychia infection of three weeks' duration.

hanging nail root without injury to the radix and the cuticle. If the purulent material has extended completely across the base of the nail, it may be necessary to remove the entire base of the nail. This, however, can be done without resorting to a radical surgical procedure which is so frequently advocated in the textbooks such as a double incision, one incision being placed on each side of the base of the nail; the base of the nail is then elevated and removed.

In chronic infections, if the drainage becomes seropurulent and healing is slow, the chance that a portion of the dead nail root remains and is acting in the capacity of a foreign body should be considered. If this is the case and the portion of the dead nail root is removed, the drainage will subside. Treatment after removal of this remaining portion of the dead nail root,

of tissue and formation of abscess appear, the tension is released and the sensitiveness disappears. At this period there is bony

Lymphangitis at its beginning may simulate a bone felon in that pain and swelling occur in the finger but, usually, by the time



FIG. 2. Bone changes noted ten days after onset; treatment consisted of late incision and drainage. Anteroposterior and lateral views.



FIG. 3. Bone changes four weeks after onset. Absorption of distal three-fifths of the phalanx may be noted. Anteroposterior and lateral views.

involvement and, regardless of the treatment instituted, there is rapid destruction of the phalanx. Roentgenologic examination in the early stages does not reveal any abnormality, but when bony involvement occurs, a fuzziness may be noted on the palmar aspect of the phalanx in its middle or distal thirds. Destructive changes take place within a few days and, as early as a week to ten days after onset of symptoms, marked destructive changes may be noted. (Figs. 2 and 3.)

To make a definite diagnosis of bone felon the condition should be distinguished from tenosynovitis, lymphangitis and subepithelial abscess. In infections of the tendon sheath the finger usually is held in a flexed position and the whole finger is enlarged symmetrically. On attempting extension there is severe pain and on palpation, tenderness extends proximally over the course of the tendon sheath. There is an absence of the excruciating, continuous pain and the exquisite localized tenderness found in the presence of a bone felon.

these infections come to the attention of the physician, the diagnosis is established by the appearance of the dorsum of the fingers and hand. This type of infection is evidenced by characteristic red streaks. The swelling is also more extensive and there is an absence of the localized swelling of the distal phalanx and the extreme localized pain noted in bone felons. In lymphangitis the finger can be moved with relatively little or no pain.

Subepithelial abscess over the distal phalanx may in its inception simulate a beginning bone felon. This lesion presents a small area of redness, slight swelling and tenderness. There is, however, an absence of the characteristic continuous pain and tension of the ball of the distal phalanx seen in felons. There is an early localization of the infection with superficial formation of abscess readily seen beneath the skin.

The diagnosis of bone felon should be made early so that adequate treatment may be instituted. The treatment consists

of early surgical incision for release of the tension and the promotion of drainage in the closed space. The incision is best placed at the side of the phalanx; care should be

bone. The finger should be placed on a splint for protection and comfort until the phalanx has completely reformed or is self-terminated.



FIG. 4. Same case as Figures 2 and 3; phalangeal reformation eight weeks after onset. Anteroposterior and lateral views.

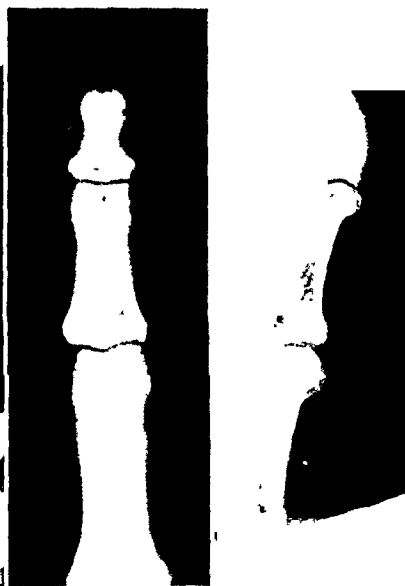


FIG. 5. One year after onset the phalanx is completely restored. Anteroposterior and lateral views.

taken not to extend the incision into the joint or to penetrate the attachment of the flexor tendons at the base of the phalanx. Midline incisions should be avoided, thereby lessening the chance of a sensitive, adherent scar in the tactile portion of the finger. The fish-mouth incision advocated by some is unnecessary and may complicate the healing and the function in the finger. Bone felons in the late stage of the infection which is often seen may rupture spontaneously and the problem is to determine if the drainage is adequate and if a sequestrectomy is indicated. If the question arises as to the proper procedure, maintenance of drainage through the opening which is already present is preferable to unwise surgical interference. In this stage the phalanx is certain to proceed to almost complete dissolution or sequestration. Every attempt should be made to protect the periosteum for reformation of the bone and even self-extrusion is more desirable than rough removal of incompletely sequestered

Preoperative and postoperative treatment should consist of warm, moist packs preferably of a 50 per cent solution of alcohol, complete rest in bed with elevation of the hand and sedatives as indicated. When the acute inflammatory process subsides, daily hand baths in sterile saline solution and the employment of light (60 watt nonfrosted bulb) for periods of several hours daily promote absorption and hasten the healing. The use of sulfanilamide and its associated drugs may be of some benefit postoperatively, but because of the anatomy of the part they offer little in preoperative treatment. Although early incision is advocated, hasty incisions should be avoided. Also, whereas early incision offers the best results and early relief of pain, the results obtained with spontaneous or late drainage compare favorably with those in cases in which the patient is seen in the first stages of the infection and adequately treated by incision.

It is well to remember how surprisingly good the end results may be despite what apparently is a total destruction of the phalanx and endless days of drainage. The course in the majority of cases of these infections is one extending over a period of weeks with slow healing and regeneration of new bone. (Figs. 4 and 5.) Amputation

is rarely if ever indicated and should be considered only in those cases in which there is an associated infection in the joint.

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ACHONDROPLASIA . . . is a curious congenital condition, somewhat resembling rickets, in which the growth of those bones developing from cartilage is cut short and interfered with by virtue of premature synostosis with the epiphysis.

From—"Rose & Carless Manual of Surgery," Edited by William T. Coughlin (The Williams & Wilkins Company).



# TREATMENT OF FRACTURES OF THE CLAVICLE, RIBS AND SCAPULA\*

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## FRACTURES OF THE CLAVICLE

EIGHT to ten per cent of all fractures occur in the clavicle, and probably there is no other bone the fracture of which causes less permanent disability, severe complications or deformity. A confusing array of mechanical devices for fixation have been described, and it is our object to outline a method of treatment which can be carried out utilizing the simplest of surgical supplies.

The clavicle is ossified at birth save for the two extremities, and this probably accounts for the high frequency of fracture in childhood and adolescence. The fracture usually occurs in the middle third of the bone. The inner fragment is displaced slightly upward by the attachment of the sternocleidomastoid muscle. Unopposed by the strut-like support afforded by the intact clavicle, the pull of the pectoral and scapular muscles, plus the weight of the arm, cause the outer fragment to become displaced distally and inward. Fractures of the outer and inner quarters of the bone are rare and usually show very slight displacement.

*Diagnosis.* Because of the palpable deformity and the sensation of grating in the clavicular region, the diagnosis of "broken collar bone" is frequently made by the patient. In most instances an almost pathognomonic attitude is assumed—the head is inclined toward the injured side, the elbow is supported by the opposite hand and the shoulder on the injured side is visibly depressed.

The fracture is frequently overlooked in infants but should be suspected if following known or possible trauma the child cries on moving the arm or shows a disinclination

to use the extremity. Careful palpation will reveal a tender spot along the clavicular line or demonstrable deformity. Roentgenograms should never be omitted.

*Treatment.* The object of any type of fixation is to hold the shoulder backward and upward. There is considerable difficulty in maintaining this position, and after having tried several methods we doubt that any one method will maintain anatomic reposition or result in union without some thickening at the fracture site. In most instances postreduction roentgenograms are very disappointing because very little change in the position of the fragments has been accomplished, but thickening due to incomplete reduction disappears within a relatively short time. Any method of treatment which immobilizes the shoulder, wrist or hand is to be condemned, especially in individuals over 40 because the resultant periarticular adhesions may cause permanent crippling. The ideal method of treatment must, therefore, be one which requires a modest armamentarium, is easy of execution and allows free motion of the shoulder, elbow and wrist. The clavicular cross and its various modifications meet these requirements but it has the disadvantages of being bulky and tending to become displaced. We find that 97 per cent of all clavicular fractures can be satisfactorily treated by the figure-of-eight bandage method, provided that the bandage is carefully applied with especial attention being given to adequate axillary padding.

Anesthesia is obtained by means of 2 per cent novocaine injected into the fracture site. The patient is seated upon a low stool. Both shoulders are then drawn backwards,

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the operator placing his knee in the middle of the patient's back for counter traction if necessary. A well beveled felt pad is then

terminal portion is fastened in the interscapular region with large safety pins which are then covered with adhesive.

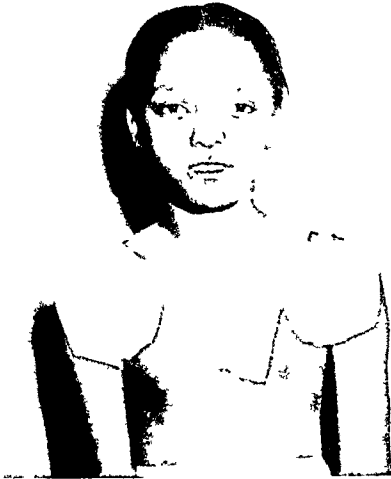


FIG. 1. The axillary pads are in place and the beveled compression pad is over the mesial clavicular fragment.



FIG. 2. Rear view.



FIG. 3. Figure-of-eight bandage has been applied and is held in place by adhesive strapping which encircles the chest.



FIG. 4. Method of tightening the bandage by means of muslin strip.

placed over the mesial fragment and held snugly in place by means of a wide strip of adhesive. Carefully fitted felt pads are then placed in the axillae, especial care being taken to cover both anterior and posterior folds. (Figs. 1 and 2.) The pads should be of the softest saddle-maker's felt and about one-fourth inch in thickness. The figure-of-eight is now applied and with each turn of the bandage an attempt is made to pull the shoulders upward and backward and the

The bandage employed is the type which is usually known as neurological roll, is five yards in length and consists of four layers of gauze folded in tubular shape. This particular type of dressing is marketed by various supply houses. The dressing has a tendency to slip up toward the neck, and this is prevented by wide adhesive retention straps over each shoulder which are held in place by a third strip which encircles the chest. (Fig. 3.) Beneath the

central portion of the figure-of-eight posteriorly is placed a strip of two inch muslin which may be tied and tightened as the

fractures, in cases showing marked comminution and in those individuals in whom the figure-of-eight dressing proves espe-

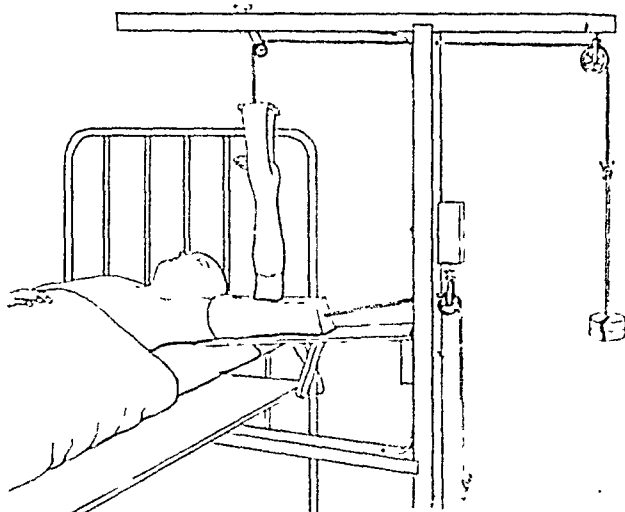


FIG. 5. Line drawing showing simple traction apparatus which may be arranged at patient's bedside.

dressing tends to loosen. (Fig. 4.) A triangular sling supports the arm for the first few days. The figure-of-eight remains in place until there is evidence of union—usually three weeks—but it may be changed if the axillary skin shows signs of irritation. The patient is cautioned to watch for any signs of circulatory disturbances or evidence of nerve pressure and to report them immediately. If the pressure of the bandage causes discomfort for the first day or two, relief is usually obtained by having the patient lie on his back with the arms moderately abducted.

Nonunion almost never occurs and if it does the disability is usually negligible. A great many authors describe brachial plexus injuries occurring as the result of pressure caused by displacement of fragments and open reduction is advised. In our experience there have been two patients so treated who showed no improvement after open replacement of the comminuted fragment, and we are of the opinion that these nerve lesions are the direct result of the original trauma's tearing the primary nerve roots and not the result of pressure by displaced bone fragments.

The recumbent method with lateral traction on the arm is advised in compound

fractures, in cases showing marked comminution and in those individuals in whom the figure-of-eight dressing proves especially irksome and who can economically afford the required three to four weeks in bed. A very simple apparatus can be arranged at the patient's bedside. (Fig. 5.) Through the medium of adhesive traction straps applied to the forearm and arm the extremity is suspended with the arm abducted 90 degrees and externally rotated 90 degrees. Five to eight pounds of traction on the arm is adequate and just enough weight on the forearm to hold it upright. After three to five weeks it is usually found that the fracture has united sufficiently to permit the use of a sling.

#### FRACTURES OF RIBS

The more exposed ribs, the fourth to the eighth, are most subject to fracture. Compound fractures are rather rare owing to the elasticity of the rib and the rather extensive muscular attachment. In fractures which are the result of direct violence the fragments are driven into the underlying pleura or lung and thus more serious complications occur. As a rule there is very little displacement of the fracture ends since the intercostal musculature acts as a splinting agent. Fractures of the ribs are very rare in children owing to the elasticity of the bone. In adults and especially in the

aged these fractures may be the result of the most trivial accident or even muscular strain, such as is occasioned in coughing.

ping may not be tolerated because of the pressure beneath the pendulous breasts. Some relief is afforded these individuals by



FIG. 6. A, adhesive dressing completely encircles the chest. The vertical strap is added in fracture of the upper ribs. B, posterior view.

There is usually the history of thoracic trauma and the patient complains of pain in the chest which is aggravated by deep inspiration or coughing. There is point tenderness over the fracture site, occasionally crepitus may be felt or heard and anterior-posterior compression of the chest on the injured side will cause sharp pain at the fracture point. Very frequently, routine anteroposterior radiographs fail to show fracture and oblique views should be taken if necessary. If the clinical evidence of fracture of the rib is conclusive, treatment should not be withheld even though roentgenographic proof is lacking.

*Treatment.* Immobilization of the chest with adhesive strapping in most instances will give the patient relief from pain. Liberal doses of morphine or codeine in a cough mixture should be prescribed to abolish the cough reflex. The adhesive strips, each three inches in width, are applied from below upward with the chest held in full expiration and they are made to encircle the chest completely. In fractures of the upper ribs vertical strips extending over the shoulder of the injured side are added. (Fig. 6.) In obese females adhesive strap-

encircling the chest with a wide elastic roller bandage (Ace), slipping being effectively prevented by stitching the edges of the bandage together in several places and adding stitched-on shoulder straps of muslin or webbing.

The adhesive dressing should be left in place for a period of three weeks and unlike strapping, which does not completely encircle the chest, will require no reinforcing.

#### FRACTURES OF THE SCAPULA

*Occurrence.* The incidence of fractured scapulae is probably less than 1 per cent of all fractures. Fractures of this bone are infrequent because of its free mobility and its heavy muscle padding.

Direct trauma is the usual cause in fractures of the exposed acromium and less frequently of the body and spine. Indirect violence is more frequently found to be the etiology, by transmission of force through the humerus, in fractures of the neck and glenoid. Indirect violence through the medium of muscle pull is the usual mechanism in fractures of the coracoid process.

*Diagnosis.* Most diagnoses of fractured scapulae are made by means of roentgenog-

raphy. The history of trauma, pain, occasionally swelling, tenderness and inability to abduct the arm are suggestive. Abduction is usually lost when this bone is fractured, since the scapula is immediately fixed by muscles of the shoulder girdle when movement of the arm is attempted.

In fractures of the body, pain and crepitus are occasionally elicited when the spine is grasped and the inferior angle manipulated. Fractures of the body are usually comminuted. The position of the fragments is generally good because of the heavy flat musculature covering the bone.

Fractures of the acromium may be diagnosed by direct palpation and comparison with the other shoulder, although usually there is not much displacement.

The diagnosis of coracoid fractures is difficult because of the deep position of this process, but pain upon abduction of the arm against resistance plus localized tenderness aid in the diagnosis.

Glenoidal fractures and fractures of the neck may or may not show displacement, depending on the amount of damage to the coracoclavicular and coraco-acromial ligaments. When displacement has occurred, the shoulder drops downward and inward and produces a deformity very similar to simple dislocation of the shoulder. However, in the former condition the head is not palpably displaced and the rotary motion at the shoulder joint is not lost. X-rays are of course indispensable.

*Treatment.* Immobilization of the arm and soft parts overlying the scapula is all that is needed in fractures of the body. A criss-cross strapping of adhesive is applied over the scapula during exhalation. The strips begin well down in front of the affected shoulder and end on the posterior chest wall of the opposite side. The axilla is padded with powdered sheet wadding, and the arm is strapped to the side with a

wide band of adhesive which encircles the chest. The forearm is supported by a clove hitch around the neck or by a sling. The necessity for, and duration of immobilization depend entirely upon the comfort of the patient. Activity is gradually resumed after three to four weeks.

Fractures of the acromium and coracoid process require little in the way of fixation, inasmuch as the displacement is usually slight and fibrous union without disability is the rule. Immobilization may be accomplished by the simple method described for fracture of the body, and in older individuals a sling suffices. Active motion is started in either case at the end of three weeks.

For fracture of the glenoid and neck with displacement in young individuals, recumbency and lateral traction, as illustrated under fractured clavicle (Fig. 5), is the treatment of choice. Traction on the arm in abduction tightens the capsule and causes the fragments to be pulled into alignment. This form of the traction is used during the period of swelling and alignment of the fragments and at the end of ten days to two weeks may be replaced by an abduction plaster. Active motion is instituted in six to eight weeks and is supplemented by physiotherapy and light massage. Elderly patients with fractures of the neck or glenoid require the most conservative treatment. Crippling peri-articular adhesions frequently follow immobilization in this age group. In these elderly individuals the disability occasioned by some displacement of the fragments is minimal as compared with the loss of function occasioned by lengthy immobilization. In these cases we advise the use of a well fitted triangular sling and the institution of active motion at the end of two weeks. This sling routine suffices in younger patients who have no displacement.



# FRACTURES OF THE BONES OF THE HAND\*

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**F**RACTURES of the metacarpals and phalanges are the most common fractures of the human skeleton. Their presence often constitutes the only injury to the patient. For this reason they are likely to excite no grave apprehension. They are frequently regarded as minor injuries and their care entrusted to those who have given no special attention to this field. In fractures of the longer and larger bones of the skeleton an immediate appreciation of the gravity of the injury leads to better care and more diligent appreciation of the principles underlying proper management.

In 1932 we presented a paper<sup>1</sup> in which we outlined the mechanism of the production of the deformities and the principles underlying the reduction and fixation of fractures of the bones of the hand. Since then a constant check of the results in these fractures has impressively convinced us of the rich functional rewards which may be expected to follow studied application of the principles outlined at that time. The importance of the principles of management of fractures of the bones of the hand has been stressed recently in well written and clearly illustrated papers by Owen<sup>2</sup> and also by Rider.<sup>3</sup> In the present paper it is our purpose to emphasize certain practical applications of the principles of management to clarify points which have caused some confusion.

In general it may be said that the deformity following fracture of any bone may result from the direction of the force which produced the fracture; or the resultant action of opposing muscle groups attached to the fractured bone; or a

combination of these factors. While the direction of the force which produced the fracture may influence to a considerable extent the position of the fragments of the injured bone, it is remarkable that in many instances fractures sustained at the same level usually result in a similar deformity directly related to the action of the intrinsic muscles whose tendons insert on the bones of the hand.

An appreciation of the functional anatomy of the intrinsic muscles and tendon insertions in the hand will assist greatly in an understanding of the principles employed in the treatment of these fractures.

*Movements of the Fingers.* Two separate series of movements occur in relation to the articulations of the fingers: flexion and extension (at the metacarpophalangeal and interphalangeal joints), and abduction and adduction (at the metacarpophalangeal joints only). The movements and the muscles concerned are given in Table 1.

TABLE 1

Flexion	Extension
Flexor digitorum sublimis	Extensor digitorum communis
Flexor digitorum profundus	Extensor indicis proprius
Lumbricales (acting on the metacarpophalangeal articulations)	Extensor digiti quinti proprius
Flexor digiti quinti brevis	Lumbricales (acting on the interphalangeal articulations)
Abduction	Adduction
Flexor brevis and opponens digiti quinti (from the medial side of the hand)	Volar interossei (to the midline of the middle finger)
Dorsal interossei (from the midline of the middle finger)	

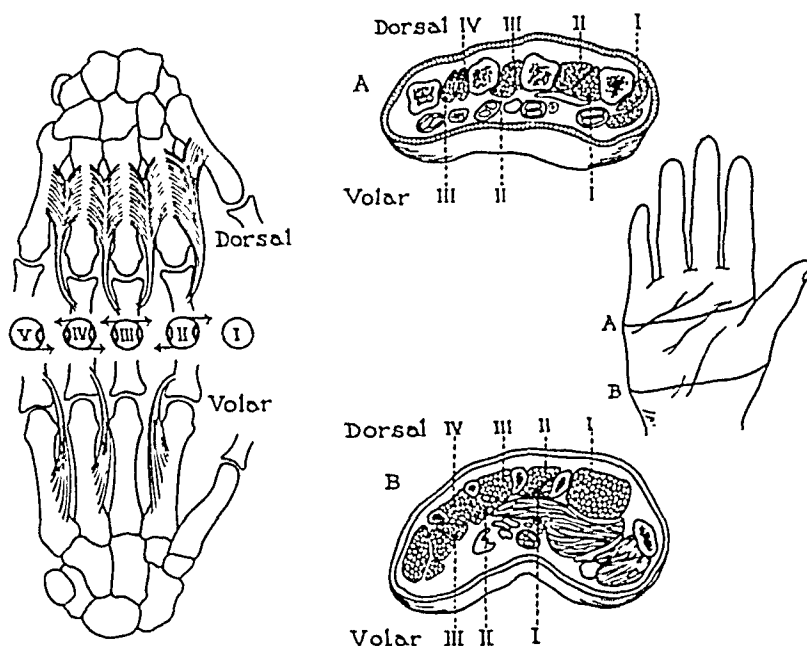
The flexor digitorum profundus acts on the terminal phalanges. The flexor digi-

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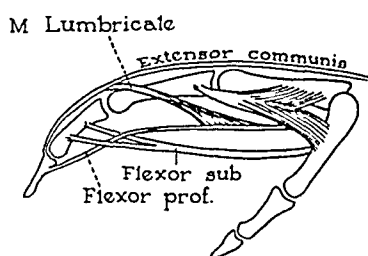
torum sublimis and the flexor digitorum profundus together flex the proximal interphalangeal joint. Flexion of the metacarpo-

phalangeal joint. Flexion of the metacarpo- Separate extension of the index finger only is possible; the three inner fingers can extend completely only together because

### Mm. Interossei



### Mm. Lumbricales



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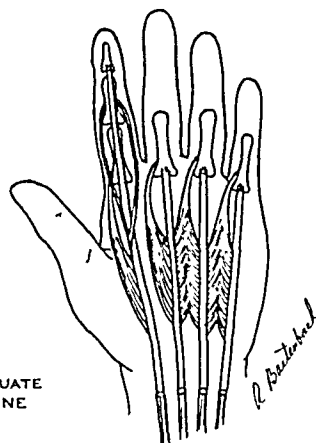


FIG. 1. The interossei and lumbricales. Origins, insertions and actions; diagrammatic.

phalangeal joint is effected by these muscles assisted by the interossei, lumbricales and flexor digiti quinti brevis. Extension of the phalanges is brought about by the united action of the extensors of the digits, the interossei and the lumbricales. Extension of the fingers at the metacarpophalangeal joints is produced solely by the long extensor muscles.

of the connecting bands joining the extensor tendons on the back of the hand.

The arrangement of the interossei and lumbrical muscles and the insertions of the flexor and extensor tendons are illustrated in Figure 1.

*Fractures of the Distal Phalanx.* The terminal phalanx articulates with the middle phalanx. When fracture occurs the

distal portion is free and not subject to the action of either the intrinsic or extrinsic muscles. It is here that considerable

Moulding of the fragments into line with simple immobilization, including the distal joint for a period of two weeks is usually

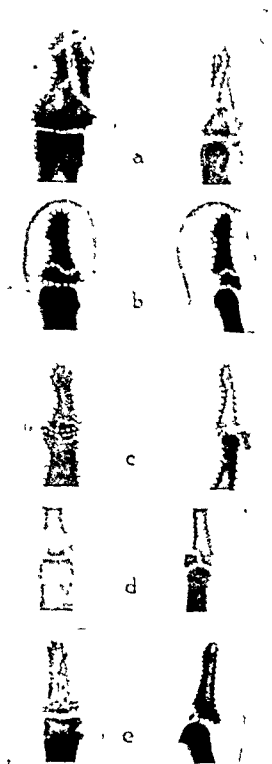


FIG. 2. Fractures involving the distal phalanx. The distal portion may show much fragmentation with little displacement. The proximal portion is influenced by the pull of the extensor or flexor muscles.

crushing may occur with but slight displacement. (Fig. 2A.) The comminuted fracture is often associated with a hematoma beneath the nail. In many instances it is necessary to relieve the pressure on the distal phalanx by evacuation of the hematoma through a drill hole in the nail. Failure to do so may result in necrosis of the distal fragments due to occlusion of the supplying vessels as they pass through the anterior closed space of the terminal phalanx. Fractures through the midportion of the distal phalanx are commonly associated with loosening of the nail due to elevation by a hematoma. It is inadvisable to remove the nail since it acts to some extent as a suitable splint.

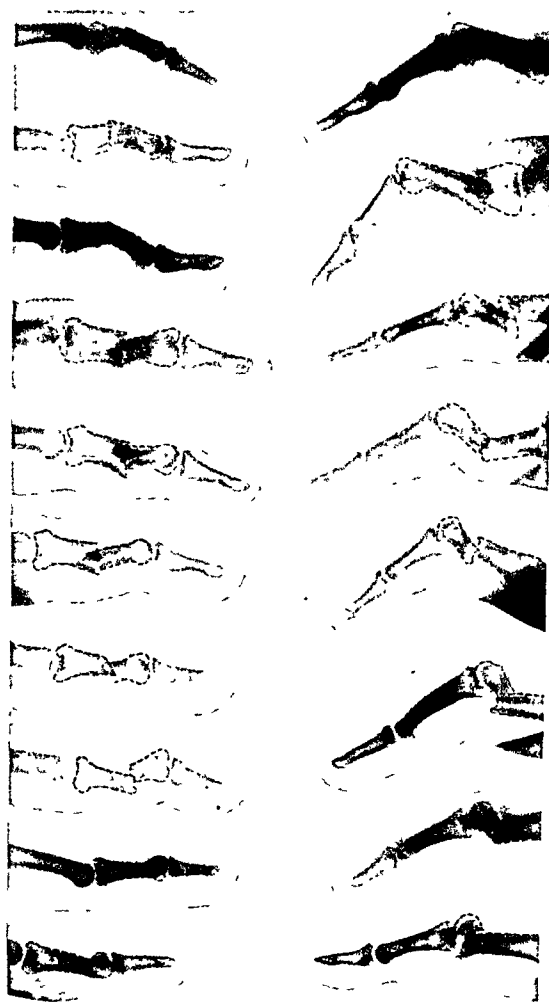


FIG. 3. A, fractures of the middle phalanx. Fractures in the proximal portion show the inverted v deformity. Fractures in the distal portion show the v-shaped deformity. B, fractures in the proximal phalanx. At all levels there is the v-shaped deformity.

ample for relief from symptoms. While x-ray examinations show that healing is complete in approximately five months,<sup>4</sup> a much shorter period of fixation suffices.

Fractures involving the proximal portion of the terminal phalanx are subject to the action of the flexor digitorum profundus and the extensor digitorum communis. A fracture here may develop a varying degree of dorsal displacement of the proximal fragment. (Fig. 2B.) Occasionally, the entire proximal fragment may



be evulsed. (Fig. 2c.) In tendon avulsions the flexor or extensor tendon may take with it its bony insertion (Fig. 2D and E).

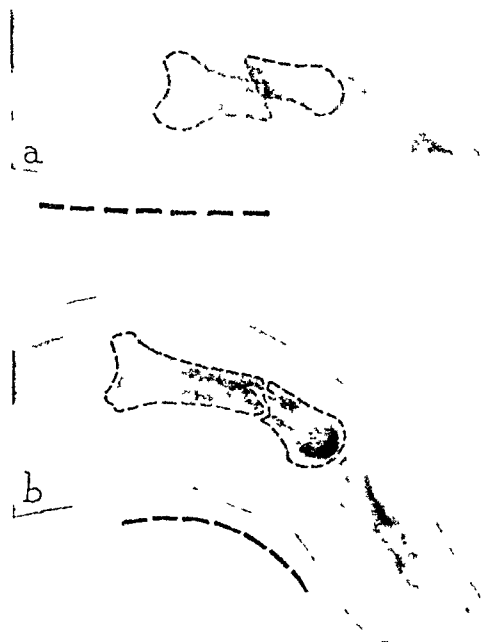


FIG. 4. The volar projecting spur as a result of fixation on a straight splint.

Fractures of the proximal portion require such immobilization as will approximate the fragments. The fracture illustrated in Figure 2c requires open reduction, 2D requires hyperextension and 2E requires hyperflexion. When hyperextension is required for treatment of the "dropped finger" or "baseball finger," immobilization in the correct position for a period of approximately six weeks is necessary. The Lewin splint is satisfactory for this purpose.

*Fractures of the Middle Phalanx.* Fractures of the middle phalanx often show no deformity and require simple immobilization. In many instances, however, a deformity related to the action of the flexor digitorum sublimis is present. This muscle ends in a tendon which divides into two portions. They insert on the volar surface of the middle phalanx, at approximately the midportion. The deformity usually noted following fracture of the middle phalanx depends on the location of the fracture site. If this site is distal to the insertion of the tendon, there

occurs flexion of the proximal fragment and dorsal displacement of the distal fragment. When the fracture site is proximal to the tendon insertion, there results flexion of the distal fragment with the proximal fragment in an extended position. The accompanying illustration showing different sites of fractures of the middle phalanx demonstrates this. (Fig. 3A.) Failure to take into account these two types of displacement of fragments will result in a failure to correct this deformity. When a straight splint is used for fixation of a fracture distal to the insertion of the tendon there results most commonly a palmar projecting spur, which interferes with flexion of the distal phalanx. (Fig. 4A.) Adequate fixation can be had by bringing the distal fragment into line by a curved splint, restoring the fragments to a natural arc with proper alignment of the fragments. (Fig. 4B.) Fractures into joints and oblique fractures with overriding require longitudinal traction in addition to fixation for a more favorable result. Immobilization for a period of three weeks is usually necessary in the treatment of fractures of the middle phalanx.

*Fractures of the Proximal Phalanx.* The resulting deformity when fracture of the proximal phalanx occurs is fairly constant regardless of the site of fracture. (Fig. 3B.) Flexion of the proximal fragment is brought about by the action of the interosseus and lumbrical muscles while dorsal displacement of the distal fragment is due to the action of the lumbrical muscle alone.<sup>5</sup> Here again fixation on a straight splint will maintain the deformity and result in impaired function. When the distal fragment is brought into line with the proximal fragment by fixation on a curved splint, a minimum of deformity will result. Immobilization for three weeks is usually necessary for sufficient union to permit active and passive motion.

*Fractures of the Metacarpal Bones (Exclusive of the Thumb).* Fractures of the metacarpal bones usually result in typical deformities characterized by shortening

of the length of the bone due to bowing of the fragments. There is a dorsal projection at the site of fracture and volar

joint to the proximal phalanx and is drawn into a flexed position. This accounts for depression of the knuckle. "Recession" of

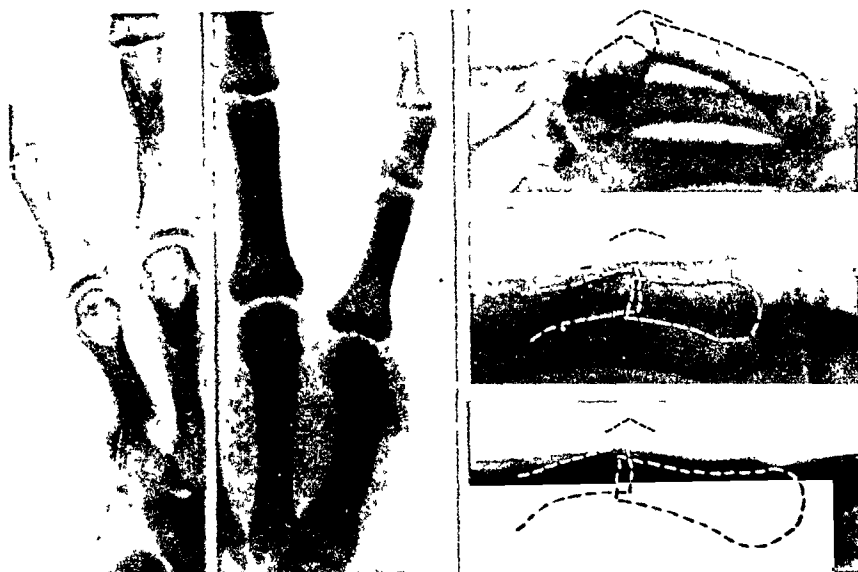


FIG. 5. The inverted v deformity in fractures of the metacarpal bones: Lateral displacement in the second and fifth metacarpal bones.

#### The Thumb

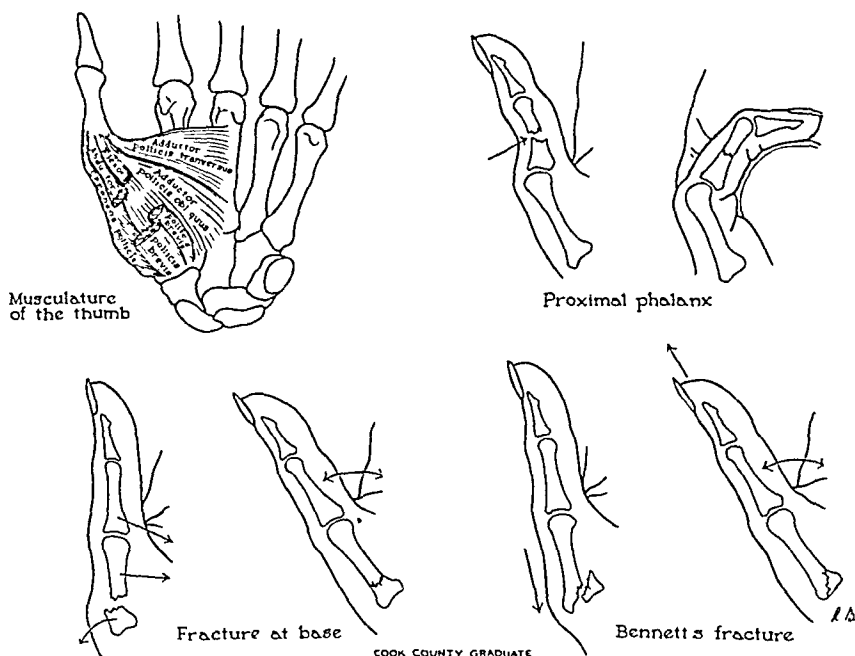


FIG. 6. Mechanism of deformity in fractures of the thumb.

displacement of the metacarpal head. (Fig. 5.) This deformity is the result of the action of the interosseus muscle which is a flexor of the proximal phalanx. The distal fragment of the metacarpal bone is attached through the metacarpophalangeal

the knuckle is due to the prominence of the distal portion of the proximal fragment. The treatment of these fractures requires immobilization for a period of three weeks on a straight dorsal splint. This restores the normal horizontal contour of the

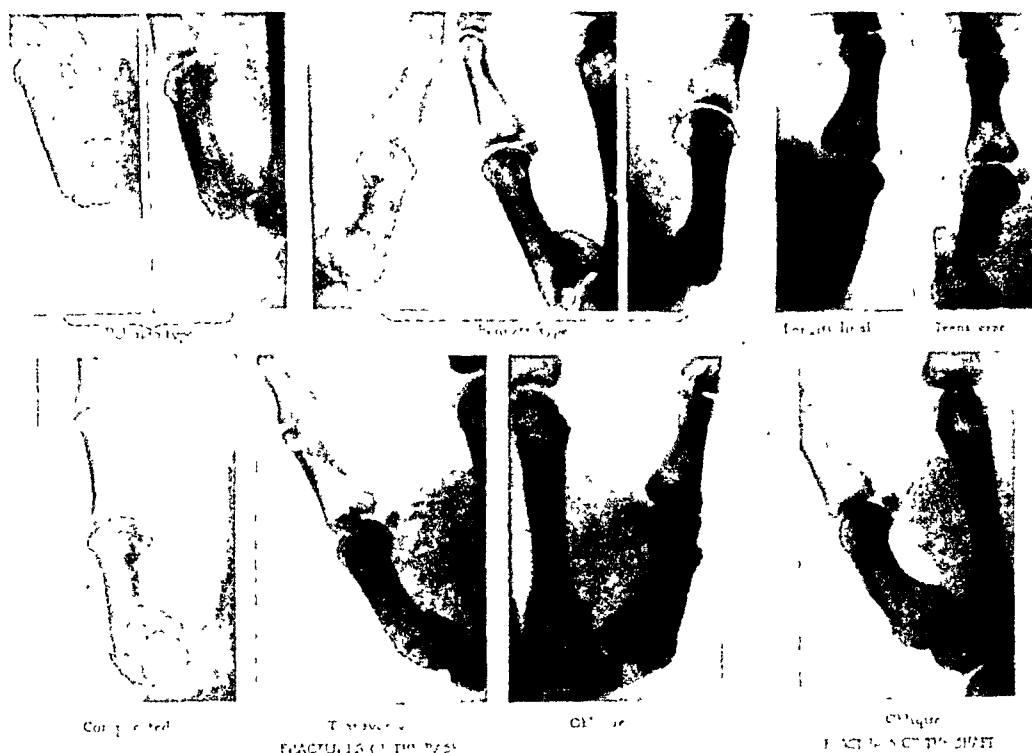


FIG. 7. Types of fractures of the thumb.

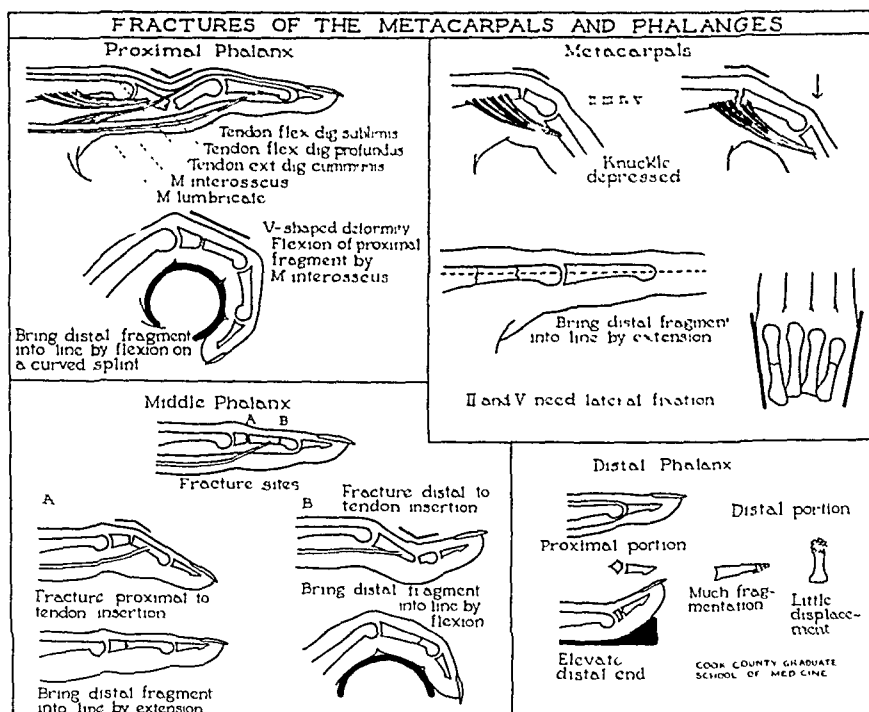


FIG. 8. The basis for mechanical fixation in fractures of the bones in the hand.

dorsum of the hand. Fractures of the third and fourth metacarpal bones are splinted laterally by their adjacent metacarpals. The second and fifth, when fractured, require lateral splinting in addition to dorsal splinting.

#### FRACTURES OF THE THUMB

*Fractures of the Distal Phalanx.* The treatment of fractures of this bone conform to the same principles as outlined for the other distal phalanges.

*Fractures of the Proximal Phalanx.* When fracture of the proximal phalanx of the thumb occurs there usually results a v-shaped deformity. The proximal portion is adducted and flexed due to the action of the adductor muscles of the thumb and the flexor pollicis brevis. (Fig. 6A.) Fixation on a curved splint or roller bandage will overcome the deformity.

*Fractures of the First Metacarpal.* In 1933 we presented a classification of fractures of the first metacarpal bone with a discussion of the anatomy and mechanism involved in the various types of fractures.<sup>6</sup> (Fig. 7.) The usual deformity is adduction of the distal fragments with abduction or extension of the proximal fragment. Treatment by marked abduction so as to preserve the web of the thumb and avoid contracture of adductor muscles is essential. (Fig. 6B.)

In the Bennett type of fracture, if marked abduction fails to restore the alignment and overcome the dislocation of the shaft, traction in addition to abduction is necessary (Fig. 6C.) Immobilization for three weeks with subsequent careful use is necessary for healing.

The materials used in the maintenance of these corrected positions are those commonly used in other fractures: tongue depressors, strips of aluminum, adhesive tape, roller bandages of various sizes and Plaster of Paris.

In a study of fractured bones, Zuppinger made use of fundamental geometrical principles in explaining and designing the use of various mechanical applications of force

to produce correction of the deformity. Practical application of Zuppinger's studies is exemplified in the ingenious method of application of a malleable volar splint applied to the finger in extension and firmly secured by adhesive material. The splint is bent in a curved manner carrying the finger in an arc of palmar flexion. This maneuver increases the length of the dorsal arc, thereby producing traction as well as affording a natural curved support for the fractured member. In such applications as this, one should be careful to preserve the blood supply to the part. The necessity of frequent examinations and avoidance of undue pressure or constriction cannot be overemphasized.

Compound fractures of the metacarpals and phalanges are met with very frequently. One must decide at once in these injuries the character and extent of the damage and plan the treatment to the end that the patient will have the best functioning hand which can be salvaged. Where the soft parts are greatly damaged the operative manipulation of fractures may serve further to contaminate the wounds or impair the vitality of the tissues. In these cases one may be compelled to restrict his activities to a thorough debridement coupled with the simplest of corrective splinting and dressing. As improvement occurs one should constantly attempt to restore the member and its injured parts to a position which will insure ultimate usefulness. Skeletal traction while of advantage in the alignment of the fractured bone may serve to decrease the blood supply to the injured soft parts. It is better to postpone active traction until the vitality of the soft parts is assured. The necessity of cleansing the wound with the avoidance of strong chemical antiseptics cannot be overemphasized.

#### SUMMARY

A summary of the metacarpal and phalangeal deformities with general principles of management is illustrated in Figure 8. It is evident from these illustrations that

the principle of aligning the mobile distal fragment with the less mobile proximal fragment is applicable to all fractures of the bones of the hand.<sup>7</sup> This rule simplifies the essentials of treatment and relieves one of remembering the mechanisms involved in the various displacements.

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THE application of some form of splint is the first procedure in the treatment of every fractured limb. . . . The need of immediate immobilization of compound fractures is most urgent.

From—"Fractures and Dislocations for Practitioners" by Edwin O. Geckeler (The Williams & Wilkins Company).

# A FINGER SPLINT THAT WILL NOT IMPAIR HAND FUNCTION\*

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NOT long ago, due to a severance of the extensor tendon of my index finger, I found myself in need of something that would maintain extension of my finger yet permit good usage of the rest of the hand. This explains my interest in finger splints.

During the first five to seven days after injury, one is perfectly willing to be quiet, not using the hand, because of pain. After this, there is no good reason why one should not be able to use the other fingers of the hand, but the usual gauze bandage and splints practically prohibit effective usefulness. Within a few days, several factors of greater or lesser importance presented themselves as objectionable features in the customary methods of splinting fingers. These can be mainly grouped under (1) personal discomfort, (2) disability due to the mechanical appliances, (3) physiologic disturbances due to bandaging and immobilization of the finger.

It is natural to expect some pain from a wound deep enough to cut a tendon, but one's general comfort can be considerably promoted by eliminating a few disagreeable details connected with a cumbersome splint. It was particularly noted that the extension of the splint beyond the finger made it necessary to guard every movement of the hand, otherwise the splint would strike against something and cause pain in the finger. Bulkiness of the splint, gauze and bandages between the fingers abducted the adjacent fingers enough to be uncomfortable. Also, the gauze in apposition to the wound adhered to the suture line and caused a burning pain when an

attempt was made to use the hand. This pain is due to a slight slipping or movement of the splint, producing a tug on the raw surface of the wound by the adherent gauze. Soiling of the gauze bandage required frequent changing, and this is not only uncomfortable but undesirable.

Aside from the pain and discomfort as mentioned above, extension of the splint down the palm of the hand impaired the usage of the entire extremity. Scrubbing is entirely out of the question for weeks, because of the splints used to maintain extension. It is impossible to use gloves over a bandage. Because one cannot scrub or use gloves any possibility of doing any sort of surgical procedure is precluded. In other words, the splint keeps one from working.

The circular bandage wrapped about to maintain the splint, or the plaster splint applied to the finger impairs the circulation of the finger, particularly its tip. This undoubtedly retards healing. Unless the splint or cast is applied quite snugly there is some difficulty in maintaining extension.

Some of the above may seem to be trivial complaints, but nevertheless, all added together over a period of time, present a reminder that there should be a better way to splint a finger and enjoy the security of the splint without enduring so many inconveniences.

Collodion seemed to answer the purpose better than any other substance used as a splint. Because it is effective, comfortable to the patient, and materially diminishes the period of disability, I have deemed it worthwhile to call this method of splinting

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to the attention of men doing general surgery. It may have been used before, but certainly not so much as it should be.

Collodion serves the purpose of any other

through it. If serum should accumulate, which did not occur in my case, the collodion can easily be removed by peeling it off from one side to the other.



FIG. 1. Anterior view, showing extent of application of collodion.

splint and adds many advantages. Some disadvantages are peculiar to collodion alone, but the advantages outweigh these.

Ordinary collodion is used in preference to flexible collodion. It must not be too thin. It is applied with a cotton applicator from the middle of the lateral surface on one side to the middle of the lateral surface of the other side, then it is rapidly applied over the dorsal surface of the finger. In the distal phalanx, it is only necessary to extend the collodion from the tip of the nail to just above the second phalangeal joint. After one coat has been applied, a second is applied immediately and then a third may be added. It is a good idea to place the two index fingertips in apposition and exert a little pressure, so as to produce a slight hyperextension. When the collodion dries and contracts the extension will be increased; if too pronounced, this causes pain. A slight extension is sufficient, as contraction of the collodion will produce the proper amount of hyperextension.

Collodion may be applied directly over the wound without any gauze beneath it. The collodion is sterile and transparent; the condition of the wound can be watched



FIG. 2. Lateral view, showing hyperextension of finger and reduction of swelling at fingertip.

It was noticed that the swelling was entirely relieved a short time after the collodion splint was applied. The collodion contracts, causing a reduction in size of the member rather than a swelling. I am firmly convinced that the circulation is better with the collodion method of splinting.

Collodion seems to permit the skin to heal better under it. The epithelium proliferates and spreads rather than piling up along the edges of the wound. When gauze is applied to the finger and firm bandage added, there is a tendency for the wound margins and the skin about them to become red and tender. The margins of the wound do not approximate themselves as firmly and completely as they do with the collodion dressing.

The collodion can be peeled off readily without pain and can be re-applied in a moment with the utmost ease. One can use the hand naturally and know that the finger is splinted; one can bathe, and there is no large white bandage for everybody to notice and comment on. This last saves endless and tiresome explanations.

# IMPROVED MANAGEMENT OF GANGRENE OF THE FOOT

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OUR interest in the subject of arteriosclerotic and diabetic lesions of the foot was aroused by the very poor results reported in the literature,<sup>2</sup> the average mortality reported following major amputations being about 30 per cent. At the University of Minnesota Hospital, over a five year period (1930-1935) the mortality following major amputations for arteriosclerotic and diabetic lesions was 24 per cent. The reported morbidity also is appalling, Taylor reporting that only 20 per cent of patients had primary healing of the stump. He also reported an average hospital stay of fifty days.

It has been calculated that, classifying infection as "avoidable," there should be about 5 per cent mortality in major amputations from unavoidable causes. Very few reported series even approach this figure.

After observing the methods of Dr. A. A. Zierold at the Minneapolis General Hospital, and using his method and technique for one year, we can report a definite improvement in results. The yearly mortality from 1930 through 1937 had varied from 27 per cent to 30 per cent, about fifteen major amputations being done each year. In the one-year series here reported, twice as many amputations were done without a single death. Our cases are not selected and a report is given of every patient seen from July, 1938 through June, 1939.

A common subterfuge in reporting an operative series is to treat conservatively all poor risk patients. We have not resorted to this. In previous years at Minnesota General Hospital, about 52 per cent of patients in the group under consideration were subjected to major amputation, while

in our series, 70 per cent (twenty-eight patients) had major amputations. This figure is in agreement with those reported in other series, indicating that we have not been too radical in advising amputation.

Obviously, the poor results commonly seen are due to a generally accepted but faulty method of handling cases of diabetic or arteriosclerotic gangrene of the foot. Close preoperative coöperation between physician and surgeon has improved the results of therapy. John found that eleven surgeons who coöperated with the medical men had a collective mortality rate of 3 per cent, while one surgeon who refused to delay amputation until diabetes was controlled, had a mortality of 18 per cent. We should like to emphasize strongly that major amputation never should be an emergency procedure in diabetes and arteriosclerosis.

*Pathology.* Arteriosclerotic and diabetic lesions on the lower extremities may be present purely as a result of infection; they may be the result of vascular occlusive changes; or there may be a combination of these factors. One bilateral periungual infection of the great toes in a diabetic was seen in this series and was successfully treated by saline soaks. These lesions usually are not serious but may become so, in diabetics. Interdigital epidermophytosis is the most frequent precipitating cause of diabetic gangrene. One case of chronic osteomyelitis of the tarsus in a diabetic was successfully treated by repeated application of plaster casts.

Dry gangrene is dry because the primary lesion involves arterial occlusion with ischemia of the tissues which are effectually drained of tissue fluids by means of the veins and lymphatics. This type of



gangrene can no more become infected than can a mummy, although the granulation tissue at the line of demarcation can

in this series when the temperature of the patient was above 100 degrees. To lower the temperature and pulse rate in any



FIG. 1. White female, 65, entered hospital with infection and gangrene of first and second toes of right foot of three months' duration. The dorsalis pedis pulse was absent, temperature ranged to 102 daily and the pulse rate was about 120. During four days of conservative régime, four toes became involved and a plantar abscess developed. Debridement was done, excising four toes and the heads of the metatarsals. The highest temperature after debridement was 101 and pulse was 104. After five days of 40 per cent cod liver oil ointment dressings, low thigh amputation was done. Milk culture made from the amputation site was positive for gas-forming organisms but no serum was given. The highest temperature after amputation was 99.4 on the eighth day and pulse 118 on the third day. Total hospital stay was twenty-two days (thirteen days after amputation). A, original lesion. B, wound after debridement. C, healing stump six days after amputation. Patient left the hospital in good condition, but died within the next year of intestinal obstruction caused by a gallstone.

become infected. Moist gangrene occurs when venous or lymphatic return is impeded and the tissues become waterlogged either because of primary venous disease or more usually because of infection, gangrene being secondary to toxic vascular and tissue change. This concept does away with loose talk about dry gangrene becoming infected and puts cause and effect in their proper sequence. Arteriosclerotic patients most often develop dry gangrene because of progressive vascular damage, while diabetics usually have moist gangrene without premonitory vascular symptoms because of the well known predisposition to infection. This explains the variation in mortality in the two groups.

*Theory of Debridement.* It is our opinion that the high mortality in major amputations for arteriosclerotic and diabetic gangrene is partially due to the fact that the patient is incorrectly prepared for operation. A patient with an elevated pulse rate and a septic type of temperature curve is not a good candidate for any major operation. No major amputation was done

case of gangrene of the foot where major amputation is necessary, the patient is taken to the operating room and under general anesthesia (pentothal intravenously or cyclopropane by inhalation) all necrotic tissue is removed by sharp dissection until a flat, bleeding wound is produced. This debridement may include one or more digits, metatarsals and all overhanging soft tissues. This wound then is covered with a heavy layer of 40 per cent cod liver oil ointment and a sterile dressing is applied. There being now no source of toxic absorption, the temperature and pulse rate drop promptly and dramatically to near normal by the next day. Herein lies the benefit of the procedure, but also a source of great danger. The surgeon, in the presence of a normal temperature and pulse and with a clean-appearing wound, is tempted to procrastinate and see if the lesion will not spontaneously heal. Within three to five days, however, the bacteria already in the wound, begin to make their presence known by septic temperature again, the wound develops an unhealthy

gray color and the favorable time for amputation has been lost. Debridement can be compared to scraping off the bacterial colonies from the surface of a dish of culture medium. It then takes a few days before a heavy bacterial growth appears again. In the early phases of our experience, when we did not appreciate that debridement is a preliminary to major amputation and not a final form of treatment, we have seen patients who had two or three debridements only to die of septicemia without amputation. Our procedure is to debride the wound thoroughly, and, after the patient's temperature has been down for about two days, perform a major amputation. This debridement should not be confused with local amputation which has entirely different indications and is a final procedure in itself in a limited number of cases. Debridement is indicated only in cases of septic temperature, where the lesion is on the distal part of the extremity and where major amputation is required.

*Operative Technique.* When the diabetes has been regulated and the patient's general condition is brought to as near normal as possible, by debridement if indicated, the patient is ready for operation. Cyclopropane was used routinely as an anesthetic in our series. The time element in any operation is very important, but time must not become a fetish with the surgeon. Our procedure we call the anatomic method, each structure being recognized as it is exposed and every vessel grasped with a hemostat before it is cut. In this way the operation progresses in an orderly fashion, there is no blood loss and the patient does not develop shock. A 30 per cent mortality in patients operated upon in ten minutes is not commendable; a mortality reduced to zero in patients whose amputations required thirty minutes each, is a good result.

The low thigh amputation usually has been used in this series, the skin being incised just above the prepatellar bursa and the femur about 6 cm. above the condyles. A tourniquet never should be

used in major amputations for arteriosclerotic or diabetic lesions because of the obvious danger of a nonhealing stump.



FIG. 2. Diabetic white female, 65, entered hospital because of draining sinuses in all interdigital spaces of left foot, developing on the basis of fungus infection. Necrotic tissue extruded through the sinuses and at debridement a plantar abscess was found with destruction of the soft tissues of the three middle toes. Six days after debridement, the temperature went to 101.4 and the pulse to 104. Low thigh amputation was done and the highest postoperative temperature was 100.4 and pulse 120. Stump healing was satisfactory and the patient was dismissed twelve days after amputation.

No retractors should be used on the stump and the tissues should not be severed at different levels because the blood supply goes superficially almost at right angles so that a tapered stump increases the likelihood of slough. Skin flaps are not fashioned in the usual sense of the word except that a double curved incision is made to avoid the "dog ears" at each corner. These curved skin flaps are not undercut at all. The stump is closed tightly by means of interrupted sutures of silk and no drain is employed. The drain serves no good purpose and may do harm because it necessitates a change of dressing before the optimum time.

We feel that a suitable dressing is very important and should not be left to the assistants to apply. A vaseline strip is placed over the line of incision and the

stump then is covered by a smooth, snug dressing maintained by a 5 yard gauze roll applied after the manner of a melon

one case and a small hematoma was evacuated in one instance. All other cases showed primary healing of the stump.



FIG. 3. Diabetic white female, 63, entered the hospital with infection and gangrene of the left great toe of two months' duration. During nine days of conservative régime the temperature went to 103.6 and pulse to 104. The result of debridement is shown. High amputation then was done with a postoperative reaction limited to 100.4 temperature and 108 pulse. The patient was in the hospital sixteen days after amputation. Follow-up showed satisfactory recovery.

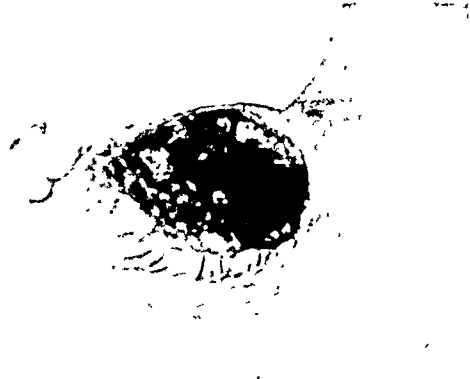


FIG. 4. White male, 60, had recurring gangrene of the great toe over a ten-year period following trauma. Amputation of the toe was done elsewhere and was followed by a nonhealing lesion which we saw after three months. Debridement was done and the temperature remained normal for five days. A lower leg amputation then was done with prompt healing of the stump permitting dismissal ten days after amputation. Follow-up was satisfactory.

head dressing. The stump is supported on a pillow and the dressing is not changed until the eighth postoperative day unless some complication arises. Early change of dressings before sutures are to be removed is meddlesome and unnecessary.

**Complications.** Septicemia, the dreaded complication of diabetic gangrene was seen in our series in three cases. One patient died during the night of admission without treatment other than efforts at regulation of the diabetes. A second patient developed septicemia while being treated conservatively because he refused amputation and the third was the patient previously mentioned who developed septicemia following multiple debridements. Infection of the stump is frequent in most reported series but was not seen in any of our patients. Photographic records of every case bear out this statement. Slough of the stump occurred in a minor degree in

Milk cultures for gas bacilli were made both distally and proximally of both muscle and skin at the time of operation in every case and in no case did gas gangrene develop. Thirty-eight per cent of these cultures showed gas formation, but the patient's clinical course was uneventful and serum was not given except in one case where one ampule was given without our order. The finding of Manson that 35 per cent of indolent leg ulcers harbor *Cl. welchii* has been unduly emphasized in some clinics. This fear of gas gangrene has led to the practice of Roentgen examination of the stump for evidence of gas in the tissues. It does not seem to be generally known that every stump will show bubbles of air, included at the time of closure of the stump. Demonstration of this included air is about as sensible as taking a flat plate of the abdomen after every laparotomy to see the air under the diaphragm. In the presence of normal temperature and

pulse, a positive milk culture may be disregarded, in our experience. In one case in this series, a leg amputation, previously done, had been followed by gas gangrene. We performed a thigh amputation in this case before the original wound was completely granulated and healing was by primary union.

*Hospital Mortality.* In the arteriosclerotic group, there were nine major amputations with no deaths and in the diabetic group there were twelve major amputations with no deaths. The only patient who died following a surgical procedure was a man who refused amputation and had drainage of an abscess after septicemia already had spontaneously developed. The patient who died following multiple debridements has been mentioned. The operative mortality for major amputations is zero and the total mortality for the year's series, including the septicemias and conservatively treated cases is 12 per cent.

*Hospital Days.* In the arteriosclerotic series, the average hospital stay was sixteen days and the average postoperative stay was eleven days. In the diabetics, the average hospital stay for those treated conservatively was twenty-one days and for those treated conservatively followed by amputation, twenty-five days. The average postoperative stay was thirteen days. The patients were dismissed with

healed stumps which did not require dressings.

*Late Results.* In the arteriosclerotic group, although the average age was 71 years, there were no known late deaths. The late results in the diabetic group, however, were not so good. One man had a toe amputation and after leaving the hospital against advice, subsequently died in diabetic coma on the medical service. Of the diabetics who had major amputation, 22 per cent died in the next year of cardiac failure, diabetic coma and obturation intestinal obstruction by a gallstone.

#### SUMMARY

A method has been outlined whereby the mortality following major amputation in arteriosclerotic and diabetic gangrene of the foot has been materially lowered. Postoperative complications have been largely avoided and the hospital stay has been greatly shortened.

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# SUPERNUMERARY METATARSAL BONE AND TOE

## CASE REPORT

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A COLORED female, age 16, had had a deformity of the left foot since birth. It had caused her considerable embarrassment and had created a constant problem in the fitting of her feet with comfortable shoes. The left foot was considerably broader than the normal right foot and presented six normally developed and functioning toes. (Fig. 1A.) A roentgenogram revealed that six metatarsal bones were present. The sixth metatarsal bone was in valgus position and was foreshortened, its shaft bowing outwards, and its broad base articulated with the cuboid bone and with the base of the fourth metatarsal bone. The fifth metatarsal was broad and short and was fused at its base to the shaft of the fourth metatarsal bone and distally to the head of the sixth metatarsal bone. The fourth metatarsal was in slight varus position and presented some maldevelopment of its head. All the toes had three phalanges except the sixth which had two. The medial three metatarsals and the tarsal bones were normally developed. (Fig. 2A.) A roentgenographic study of the right foot revealed a normal bony architecture.

the correction of an unusual hallux varus deformity.<sup>1</sup>

A diamond-shaped portion of skin was ex-



FIG. 1. Left foot. A, before operation. B, after operation.

The following operative procedure was devised to correct this deformity and was based upon a procedure employed previously in

cised from between the fourth and sixth toes, its base at the web. The apex on the plantar surface extended  $1\frac{1}{2}$  inches proximal to the web, and the apex on the dorsal surface extended  $3\frac{1}{2}$  inches proximal to the web, parallel to and between the shafts of the fourth and sixth metatarsal bones. The fifth metatarsal was exposed, detached from its bony attachments to the fourth and sixth metatarsal bones by means of an osteotome, and removed with the fifth toe. The bared surfaces of the fourth and sixth metatarsals were smoothed with a file and covered with adjacent soft tissues. The valgus deformity of the sixth metatarsal bone was corrected by the removal of a sufficient wedge of bone at its proximal end, the base of the wedge being directed medialward, and the cartilage of the adjacent base of the fourth metatarsal and the cuboid bones were removed in order to secure fusion between these three bones. The shafts of the fourth and sixth metatarsals were held approximated by a free loop of tendon (previously excised extensor digitorum longus tendon to the fifth toe), the ends of which were sutured to each other and to the



FIG. 2. a, dorsoplantar view before operation. b, after operation. c, oblique view after operation.

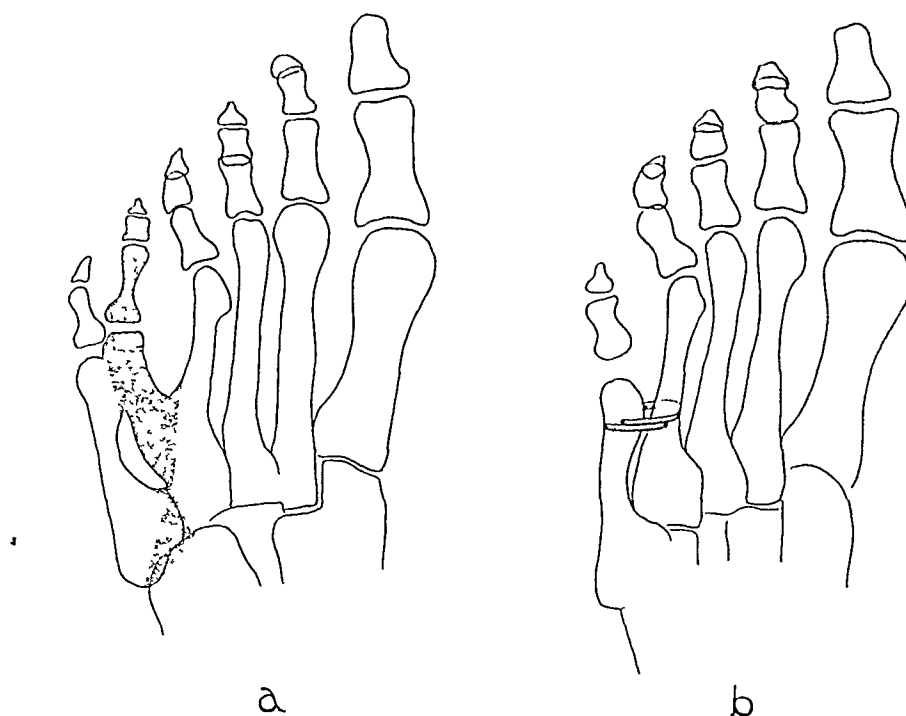


FIG. 3. Operative procedure. a, shaded areas represent bone excised. The fifth metatarsal bone and fifth toe were excised; the valgus deformity of the sixth metatarsal bone was corrected by the removal of a wedge of bone, proximally, with its base directed medialward; the articulations between the bases of the fourth and sixth metatarsal and the cuboid bones were denuded of cartilage to secure bony fusion. b, the shafts of the fourth and sixth metatarsals were approximated by a free loop of tendon (extensor digitorum longus to the fifth toe).

surrounding tissues under adequate tension. (Fig. 3.) The deep tissues were approximated with interrupted chromic catgut sutures and the skin with a continuous dermal suture. Fixation was maintained for six weeks by means of a plaster of Paris bandage and non-weight bearing was continued for an additional two weeks. The wound healed per primam.

By this method the more normally developed sixth metatarsal bone and its corresponding toe

were preserved; the scars were placed on the dorsal and plantar surfaces of the foot, away from any pressure points; and an excellent cosmetic and functional result was obtained. (Figs. 1B, 2B and C.)

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FRACTURES of the metatarsal bones which are in good position unite in four weeks, although painful excess callus may result from early weight-bearing.

From—"Fractures and Dislocations for Practitioners" by Edwin O. Geckeler (The Williams & Wilkins Company).

# TREATMENT OF A SPRAINED ANKLE\*

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A SPRAIN of an ankle is looked upon by the majority of laymen as a semiserious condition, by some as a mild affair and inconvenience, but by others as a major injury. The latter group is made up of those who know either a relative or a friend who sprained his ankle "years ago and even now the ankle will turn if he does not watch his step."

The usual procedure in treating a sprained ankle is to put on some type of adhesive strapping, give the patient a pair of crutches and warn him against weight bearing. This is continued for about two weeks. Then physical therapy is started to reduce the swelling and relieve the pain on weight bearing. Such treatment is continued for about two weeks, during which time the patient gradually begins weight bearing and as he does so the swelling and pain progressively disappear.

This method does in time relieve the condition, but in the meantime it has cost the patient considerable pain, discomfort and inconvenience as well as a medical fee. In addition, if the patient happens to be a wage earner in other than the white-collar class, there has been a decrease in his income.

To eliminate the majority of the objections to the above method of treatment, our clinic over the past three and one-half years has worked out a routine treatment which with us has been very successful. This treatment not only relieves the discomfort and pain, but materially shortens the course of treatment and the period of disability. It also practically eliminates that late phase characterized by the slow disappearance of edema, which is so distressing to both doctor and patient, particularly in women.

## TREATMENT

Our treatment of a sprained ankle is as follows: After a careful examination shows that there is no complete tear of a ligament and roentgenograms reveal no fracture or dislocation, the patient's leg is elevated to an angle of 45 degrees to reduce the swelling due to dependency. Of course, if the patient is seen a relatively short time after the accident, this type of swelling will be of no great moment. Next, those areas painful to pressure are injected with not less than 10 and never more than 20 cc. of a 2 per cent solution of procaine hydrochloride. We like to use about an 18 or 20 gauge needle, as the injection into the ligamentous tissues is easier than when using a needle of smaller bore. In five minutes the majority of the swelling caused by the injury can be massaged away.

We now make ready our adhesive tape strips. One and one-half inch tape is used. We do not favor the waterproof type of adhesive, as the back of this is rather stiff and it does not mold well around an ankle. The strapping is carried in stirrup fashion around the foot and extends up the leg to above the middle of the lower leg. Four strips of the necessary length are torn and arranged on the edge of a table that is within easy reach. Next, two strips, each three-fourths the length of the preceding four, are torn and arranged to follow the full length ones; and then two strips, each one-half the length of the full length strips, are torn and arranged to follow the three-quarter lengths.

The leg is shaved to above the height to which the strapping is to be carried. The shaved skin is painted with tincture of merthiolate, and when that dries, with

\* From the Orthopedic Department, Golden State Hospital.



mastisol. The majority of skin irritations that occur under adhesive tape will be prevented by the use of these two solutions.

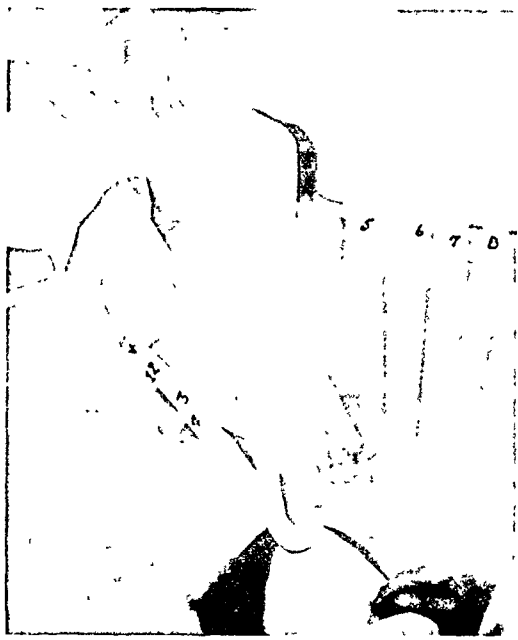


FIG. 1. Photograph showing patient on side of table, holding foot at right angle with bandage, and also adhesive strips hanging from table edge. First 4 strips have been applied.

The patient sits on the side of the examining table with the sound leg resting on a stool. He holds the injured foot by means of a piece of gauze bandage passed under the ball of the foot, the ends being held by the corresponding hands. He can thus keep the foot at a right angle and by pulling harder with one hand than with the other he can invert or evert the foot, depending on which ligament has been strained. The heel of the foot is rested on the surgeon's knee for steadiness while the strapping is being done. (Fig. 1.)

The ankle is strapped with the foot at a right angle for men and in a little equinus for women. The latter wear shoes with higher heels, and if the foot is strapped at a right angle, walking becomes difficult. Immediate weight bearing is the necessary and important second phase of the treatment. Also, because of weight bearing, we never strap an ankle in inversion or extreme eversion, but rather in a neutral position for those infrequent strains of the

ligaments on the medial side, and in slight eversion for those on the lateral side.

*Strapping.* Two full length strips of tape are applied stirrup fashion, starting the first far back under the heel and drawing it quite tight on the side of the sprain. (Nos. 1 and 2 in Fig. 1.) The second overlaps the first about one-half the width. The third full length strip is started similarly, but the ends cross on the front of the lower leg. (No. 3 in Fig. 1.) The fourth full length strip has a dual purpose. The first part is used as a binder and finisher for the ends of the previously applied strips, and the remainder is applied in stirrup fashion to reenforce the first two. (No. 4 in Fig. 1.) The first three-quarter length strip is applied unequally, so that the long end swings around the plantar surface of the arch, across the dorsum of the arch obliquely, and around the side of the ankle opposite to the strain, and is drawn quite tight. Any excess that would cover the tendo Achilles is cut off. The second three-quarter strip is applied in a similar manner, overlapping the previous one about one-half the width. (Nos. 5 and 6 in Fig. 2.) The piece of gauze with which the patient is holding the foot is removed. The first one-half length strip is applied overlapping the second three-quarter strip by one-half, and as the end on the outer side of the foot is brought around, the forefoot is pronated so that the foot will hit flat on weight bearing. (No. 7 in Fig. 3.) The forefoot is put in this position in every case regardless of the side on which the ankle is sprained. The second one-half length strip is used as a binder for the finished strapping in that portion just above the malleoli where, because of the contour of the ankle, the tape has a tendency to bridge. It is applied as a transverse band at this level but extends just beyond the edges of the first full length strip and does not completely encircle the leg. (No. 8 in Fig. 3.) The strapping is now covered with gauze bandage, which is worn for twenty-four hours, to allow for better setting of the adhesive tape.

When the strapping is completed, the patient is directed to put on his sock and shoe and begin immediate weight bearing,

gradual reduction of the swelling, and thus does not afford the necessary support. It is rarely ever necessary to continue the



FIG. 2. Photograph showing strips No. 5 and No. 6 in place.



FIG. 3. Photograph showing finished strapping, but without final gauze bandage.

walking in as normal a manner as the strapping will permit. Crutches are hardly ever provided but a cane is supplied to the more timid. The majority of patients are agreeably surprised to find that they have no pain in the joint which twenty to thirty minutes previously was very painful on weight bearing. The patient is further instructed to continue weight bearing and not to favor the ankle. After about an hour, the effect of the procaine solution has worn off and there may be some return of discomfort, but if walking is persisted in this will gradually disappear in one to two hours.

In the more laborious occupations the patient may be unable to do his full work for seven to ten days, but other patients are usually able to continue work. It has been our experience that the strapping has to be renewed about every five days because it gets loose, due to slipping and to

strapping beyond three weeks, and the average time is about two weeks.

This method of strapping affords maximum support to prevent lateral motion and still allows considerable dorsiflexion and plantarflexion. There are no straps which encircle the leg above the middle of the longitudinal arch; the whole back of the leg is open from the heel to the knee, thus there is no interference with the circulation. In a few cases some swelling may occur after the strapping is applied. Relief can be secured by cutting the encircling bands on the dorsum of the foot, but support of the ankle is still maintained. In addition, there are no straps across the tendo Achilles to cut in, as in a Gibney or basket-weave.

While the method of strapping here described has in our hands given results superior to those secured by the use of any other, we feel that the major adjuncts

to it are the injection of the painful areas with procaine hydrochloride solution and the immediate and continuous weight bearing without the aid of cane or crutches. These two, and particularly the procaine injection, seem greatly to reduce the period characterized by edema of the ankle. We have proved this to our own satisfaction by comparing the cases which were not injected, but which were otherwise treated in the same manner, with those receiving injection.

The whole procedure, after the examination, can be done in twenty minutes. The strapping alone can be done in ten minutes. No help is required.

Not only is this treatment efficacious in acute cases, but helps materially in those seen as late as two weeks after injury who are still complaining of pain and swelling. The only explanation we can offer

for the gratifying results obtained in those cases in which procaine solution is injected, is that the vicious cycle of (1) pain, (2) decreased use, (3) swelling, and (4) pain, is broken by the elimination of pain.

A typical example of the efficacy of this method of treatment is the following case:

Case No. 6946, a professional baseball player, was first seen on September 5, 1940. He had sprained his left ankle in a night game on September 4, 1940 as he slid into a base. There was considerable swelling of the ankle and ecchymosis on the lateral side of the heel, with pain on inversion and on pressure beneath the tip of the external malleolus and over the lower tibiofibular ligaments. The treatment described was applied. On September 9 the patient played a full nine-inning game.

This method has been used by us in over 500 cases. No incidence of infection has occurred.



# THE USE OF PESSARIES\*

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THE pessary, an instrument invented to hold the retroposed uterus in forward position and to raise the prolapsed uterus higher in the pelvis, was used extensively in gynecological practice during the prelaparotomy days. As abdominal surgery was developed and its safety increased, innumerable surgical procedures were devised to correct the backward displacements and prolapse of the uterus. During this period of time the service which had been rendered by the pessary was largely forgotten and its use was frequently thought of as an obsolete procedure. As time went on the pessary was rediscovered, so to speak, and, although the indications for its employment are more limited, it now finds a definite field of usefulness in the treatment of the conditions for which it was invented.

In the modern practice of gynecology the pessary is employed chiefly in the following conditions: (1) In uterine retroposition when the uterus is movable; (2) in early pregnancy in a retroposed uterus; (3) in the backward displacements of the uterus following pregnancy and labor; (4) as a trial instrument, before operation, to determine if symptoms attributed to retrodeviation are relieved by elevating the uterus and keeping it in forward position; and (5) in uterine prolapse, especially in elderly women, in whom there exist definite contraindications to operation.

*Replacement of the Uterus.* The pessary is not intended to change the position of the uterus from posterior to anterior, but rather to hold it in the anterior position after it has been brought to that station by other means. In most instances this

may be brought about by bimanual manipulations. When this is not possible, the knee-chest posture, assumed morning and night, and vaginal tamponade may be helpful and may precede the bimanual replacement of this organ. When this is accomplished, a properly fitted pessary will hold the uterus in its correct position. Occasionally the uterus sinks so deeply in the pelvis that it is not possible to replace it bimanually. If a pessary of suitable size is introduced in the vagina and the patient is instructed to assume the knee-chest position morning and night, the uterus may be found in its normal position after a week or two of such trial.

*Types of Pessaries in Current Use.* The types of pessaries in current use for retropositions are: (1) the Hodge, (2) the Albert Smith, and (3) the Thomas, sometimes referred to as the Smith-Thomas. For prolapse there are, (1) the Raudenbush, also known as the ball pessary, and (2) the Gellhorn pessary. The soft rubber inflated doughnut pessary is not as satisfactory as the Raudenbush and the Gellhorn as it causes a free, and sometimes odorous vaginal discharge, which is objectionable and distressing to the patient.

*Hodge Pessary* (Fig. 1). This pessary was invented by Hugh L. Hodge, Professor of Diseases of Women in the University of Pennsylvania from 1835 to 1863, and may be considered as the original of the hard rubber retroposition pessaries. It is still used extensively. Its wide anterior end is of value when a deep laceration of the pelvic floor is present.

*Albert Smith Pessary* (Fig. 2). This pessary is a modification of the Hodge;

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the anterior end is narrowed so that it adapts itself more readily to the narrow portion of the pubic arch, thus preventing

insertion so that it can be removed at night, cleansed and reintroduced in the morning. In my experience this pessary

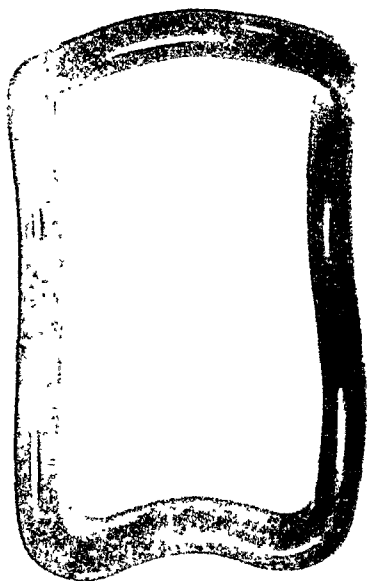


FIG. 1. Hodge pessary.

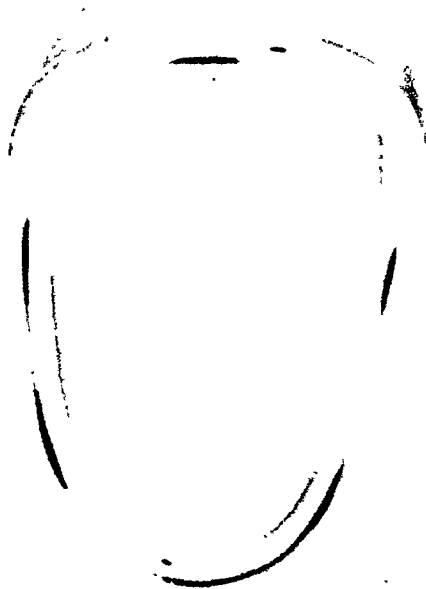


FIG. 2. Albert Smith pessary.

the instrument from turning and permitting it to assume a more fixed position.

*Thomas Pessary* (Fig. 3). This is a modification of the Smith pessary by T. Gaillard Thomas, and sometimes referred to as the Smith-Thomas pessary. The posterior bar is thickened and bulbous in character, allowing pressure on a larger surface of the posterior vaginal fornix.

A well fitted retroposition pessary does not interfere with marital relations or with the introduction of a douche nozzle. Indeed, it is not uncommon for women to become pregnant while it is being worn.

*Raudenbush Pessary* (Fig. 4). This has the appearance of a billiard ball to which a stem has been attached to facilitate its removal. It is made of hard rubber and the ball part is hollow in order to make it light in weight. It may be obtained in three sizes: small, medium and large. When the proper size is applied, a prolapse will be kept reduced in the pelvis. The patient may be instructed in its removal and

has been found to be very useful in the management of extensive prolapse in old women when operation is contraindicated.

*Gellhorn Pessary* (Fig. 5). This is a cup-shaped device with a thick stem which is effective in keeping the prolapsed organs reduced within the pelvis. This instrument is also obtainable in three sizes: small, medium and large. Its greatest field of usefulness is in older women whose physical condition makes operation hazardous. It may be removed at night by the patient and reintroduced in the morning. Its introduction is accomplished by means of a cork screw motion. In the last few years this pessary has become the most popular in the nonoperative treatment of prolapse. More recently it has been made of a plastic material known as neicomold, which is freely boilable, thus assuring perfect sterilization.

The pessary which is employed in the correction of a retroposition must hold the cervix in the hollow of the sacrum.

The important points of support are the pubic arch and the pelvic floor. If it gets adequate support from the pubic

direction to avoid pressing the tissues against the pubic arch, and thereby avoiding pain. The pessary is held by the



FIG. 3. Thomas pessary.



FIG. 4. Raudenbush pessary.

arch at its anterior end, the posterior end will elevate the posterior fornix and the uterosacral ligaments. Since the cervix is closely attached to the posterior vaginal fornix, an instrument which supports this structure will bring the cervix well back in the pelvis. As the cervix goes back, the fundus usually assumes a forward position. The size of the pessary is decided by measuring with a ruler or the examining fingers the distance from the posterior vaginal fornix, pushed upward, to the pubic arch, and a pessary slightly less than this measurement is selected. The space between the lateral bars is determined by the width of the vagina. The anterior end is bent downward so that it will not infringe upon the urethra. Several sizes and shapes may have to be tried before a suitable pessary is found.

*Introduction of Pessary.* The patient is in the dorsal position. The uterus has been replaced bimanually. The pessary has been cleansed with a nonirritating antiseptic solution and lubricated with surgical lubricant, (Irish moss jelly). The perineum is depressed with one or two fingers, the pressure being carried in a backward

anterior bar and the posterior bar is introduced in the anteroposterior diameter—or the widest diameter of the vaginal introitus—in such a way that no pressure is made upon the sensitive urethra. When partly engaged in the vaginal tube, the pessary is rotated so that the posterior bar is directed upward toward the symphysis pubis. With gentle but steady pressure the pessary is directed inward until it reaches the anterior lip of the cervix; the examining finger is passed into the vagina under the pessary and the tip of the finger depresses the posterior bar and guides it inward beyond the cervix. The pessary is now in place, the posterior end behind the cervix, supporting the posterior vaginal fornix and the uterosacral ligaments, and the anterior end behind the pubic arch.

A properly fitted pessary should not be felt and should not cause any discomfort. After a pessary has been fitted, the patient should be asked to walk about the examining room to ascertain whether or not she is conscious of the instrument. If it seems to fit properly, she is instructed to return in a week so that the vagina may be examined for pressure points. If no ab-

normalities are found, the pessary is cleaned, sterilized and reintroduced. The patient is instructed to return after each

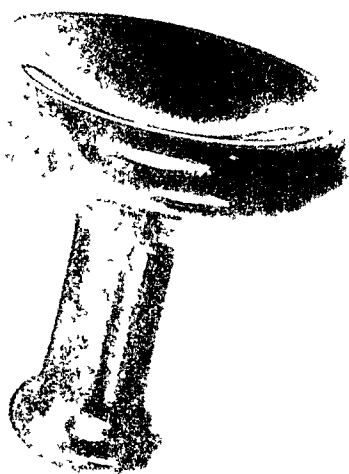


FIG. 5. Gellhorn pessary.

menstrual period for inspection of the vagina, cleansing and reinsertion of the support. The shape of the pessary may be altered by dipping it in boiling water, in the sterilizer for instance, and, while it is still soft, shaping it as necessary. The patient is also asked to douche every night in order to remove any vaginal secretion which may have accumulated during the day and to prevent vaginal irritation. A douche which has been found to be satisfactory consists of the compound zinc sulfate powder, National Formulary VI, two or three teaspoonfuls in two quarts of warm water. Inspection of the vagina every two or three months may be all that is necessary in the older woman who is wearing a supporting pessary for prolapse provided it is removed every night. It is of advantage, however, to have those with thin, atrophied vaginal walls return once a month as this type of senile vagina is easily irritated.

*Contraindications to the Wearing of a Pessary.* The pessary is contraindicated in pelvic inflammatory disease in the presence of an adherent retroversion. Since the uterosacral ligaments are frequently associated with this disorder in the form

of a posterior parametritis, the posterior bar of the pessary will cause exquisite pain by constant pressure on these tender structures. It is also contraindicated in prolapsed ovaries as pressure on these sensitive organs will occasion constant discomfort. Obviously it is also contraindicated when the parts are so relaxed that no device will remain in place.

#### *When Should the Pessary Be Discarded?*

The pessary may be discarded during pregnancy after the uterus has slipped by the promontory of the sacrum and has become an abdominal organ. After labor it usually can be given up at the end of six months, as at that time involution is complete and the ligaments of the uterus have acquired their tonus. When used as a trial instrument, it is obviously discarded after an operative procedure has been performed to keep the organ in normal position permanently. During the childbearing age it may have to be worn indefinitely for retroposition and moderate degrees of prolapse, or until such time as the patient has passed the childbearing age or has reached the menopause, when an operation may or may not be decided upon. Pessaries introduced for inoperable prolapse because of cardiac, renal, vascular or pulmonary complications, are also worn indefinitely, since their removal will allow the uterus again to protrude through the vulva.

#### SUMMARY

Pessaries find a useful, though limited field in gynecologic practice. Two general types are in common use, those which hold a retroposed uterus in forward position after bimanual replacement, and those which elevate a prolapsed uterus in the pelvis. A properly fitted instrument should cause no discomfort to the patient; it should be cleansed and replaced once a month on an average in order to prevent irritation to the vagina and a daily douche should be applied. The fitting of a pessary is a simple procedure if certain general principles described in the text are followed.

# UTERINE HEMORRHAGE\*

## TECHNIC OF UTEROVAGINAL PACKING

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THE most dramatic emergencies frequently arise in the realm of obstetrics. The outstanding one is a brisk postpartum hemorrhage which occurs with such insidious suddenness that the condition changes from a comparative good one to that of marked shock in the space of a few minutes. Such a situation requires active, intelligent and energetic treatment immediately. The first thought of course is to control the bleeding and combat the shock. If the ordinary simple measures of controlling the bleeding do not suffice, we must resort to uterovaginal tamponade before it is too late. At the same time treatment for shock should be carried out by assistants. In this respect it must be remembered that blood transfusions are excellent for the treatment of a woman who is in shock because of marked loss of blood. An attempt should be made to replace the amount of blood lost; 500 cc. or even 1000 cc. of citrated blood should be administered slowly by the drop method. When the patient has improved, more extensive measures may be instituted with a view to determining the cause and correcting the condition.

In this short article it is obviously impossible to discuss all types of uterine bleeding. The scope of this paper is limited to the severe uterine hemorrhages, which require uterine packing as one of the therapeutic measures, and the technic of uterovaginal tamponade. These hemorrhages may be divided into two main groups: (1) Those occurring with incomplete abortions, and (2) those occurring postpartum. In this latter group we encounter the most sudden and severe hemorrhages which

always require prompt and efficient therapy. These will be discussed under the following headings: Lacerations of the cervix, lacerations of the vaginal walls, rupture of vaginal varices, retained placenta with partial separation, inversion of the uterus, placenta accreta and atony of the uterus.

*Incomplete Abortion.* It is advisable to pack the uterus with gauze in incomplete abortions when the hemorrhage has been severe and alarming, and especially when it is believed that there may be some remnants left after the uterine cavity has been explored gently with a sponge-holder forceps or large dull curet. This serves two purposes: On the one hand it controls the bleeding, and on the other hand the remaining pieces of the products of conception are found on the gauze when it is removed in twenty-four hours. At the Carney Hospital we routinely inject 1 cc. of ergonovine intramuscularly five minutes before removing the gauze in these patients, in order to avoid bleeding and to cause the uterus to contract well.

*Lacerations of the Cervix, Vaginal Walls or Vaginal Varices.* When the fundus is firmly contracted and the placenta has been expressed intact with the membranes complete, and the woman continues to bleed, the cervix and vaginal walls must be inspected in order to ascertain the cause of the hemorrhage. Good exposure and rigid asepsis is very important. The anterior and posterior lips of the cervix should be grasped individually with sponge-holder forceps because these are less apt to tear the soft friable cervix. If the bleeding is from the lacerated cervix, this should be

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repaired immediately with continuous or interrupted sutures using No. 2 chromic catgut. This should be followed by a

might be caused by uterine atony, and second, to bring away with the gauze any small pieces of placental tissue which may

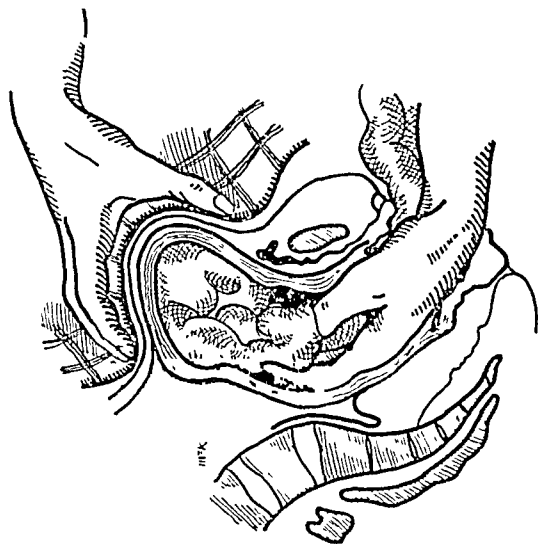


FIG. 1. Packing uterus with hands. The thumb pushes up the gauze for the fingers to pack. (DeLee's "Principles and Practice of Obstetrics"—Saunders.)

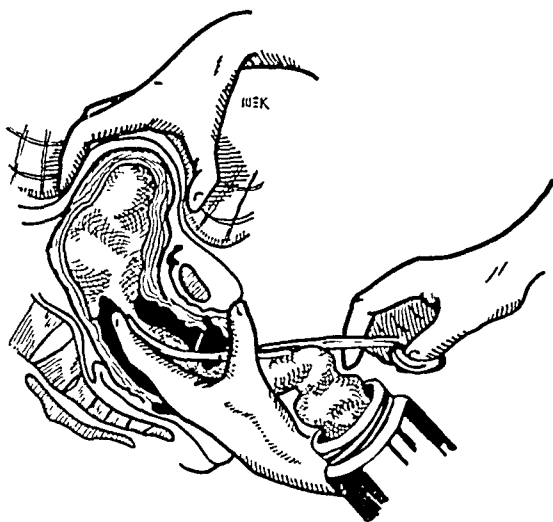


FIG. 2. Packing uterus with uterine dressing forceps. Hand is used as a direction speculum; assistant steadies fundus outside. (DeLee's "Principles and Practice of Obstetrics"—Saunders.)

vaginal pack to the cervix, lateral fornices and vagina. If the bleeding is from the vaginal walls or from ruptured vaginal varices, no attempt at suturing should be made because the tissue is so friable that suturing is unsuccessful and usually produces more bleeding. These situations are handled best by firm vaginal tamponade.

**Retained Placenta.** When there is a sudden uterine hemorrhage with the placenta still in the uterus, it may be due to separation of the placenta either partially or completely. If complete, the placenta is easily expressed with the next uterine contraction, which may be hastened by gentle massage of the fundus. If there is a partial separation, the Crede maneuver may be used. However, when we are dealing with a partial separation of an adherent placenta, which cannot be expressed by the Crede maneuver, and when the bleeding is excessive, manual removal should be performed. Titus<sup>1</sup> is of the opinion that this latter procedure should be followed by uterine tamponade for two reasons: first, in order to avoid further hemorrhage which

have been torn off during the removal procedure.

**Inversion of the Puerperal Uterus.** This condition occurs during the third stage of labor or immediately postpartum. It may be complete when the fundus passes through the cervix or incomplete when this does not obtain. The placenta may or may not be attached. The main symptoms are hemorrhage and shock.

Inversion of the puerperal uterus may be divided into acute, subacute and chronic forms. The acute forms are found immediately after delivery and should be replaced manually before the contraction ring forms. These women are in shock and are bleeding and, therefore, these two conditions must be treated immediately before any attempt at replacement is made. Sterile gauze pads should be firmly applied to the inverted uterus, and a solution of 5 per cent glucose in saline should be administered slowly intravenously, while preparations for blood transfusion are being made. When the patient's condition has improved the uterus should be replaced manually and the

uterine cavity should be packed firmly with gauze. Throughout these procedures, rigid asepsis must be maintained because these women resist sepsis poorly due to loss of blood.

The subacute type, described by Kellogg,<sup>2</sup> is one in which the inversion is found relatively soon after its occurrence, but in which the cervical contraction ring has already formed and holds the uterus firmly. His method of treatment is by traction from above during laparotomy, as described by Huntington, Irving and Kellogg.<sup>3</sup>

The chronic type is considered by most authors to be of more than one month's duration. These are treated either by the Spinelli operation, or if complicated by gangrene by abdominal panhysterectomy as reported by Phaneuf.<sup>4</sup>

*Placenta Accreta.* Placenta accreta is a condition in which the decidua basalis is completely or partially absent and the chorionic villi are in direct contact with the muscle layer (accreta) or dip down into the muscle layer (increta). As suggested by Phaneuf,<sup>5</sup> the term, "placenta accreta," as found in the literature is applied to both pathologic defects.

If the placenta has not separated one hour after the delivery of the child, a diagnosis of an adherent placenta may be made. If the Crede maneuver is unsuccessful and there is no bleeding, the patient may be treated conservatively and returned to bed with a tie on the cord which should be wrapped in sterile gauze. The patient should be watched closely for the placenta may separate spontaneously later. In the presence of bleeding, however, manual removal of the placenta should be performed. If one is dealing with an adherent placenta, the line of cleavage may be readily found and the placenta removed intact. If one cannot find the cleavage and the placenta tears from the uterine muscle, one must assume that a placenta accreta exists. The uterus should immediately be packed with sterile gauze and preparations for transfusion and abdominal supra-

vaginal hysterectomy should be begun. The patient should be given a transfusion before and after the operation if indicated.

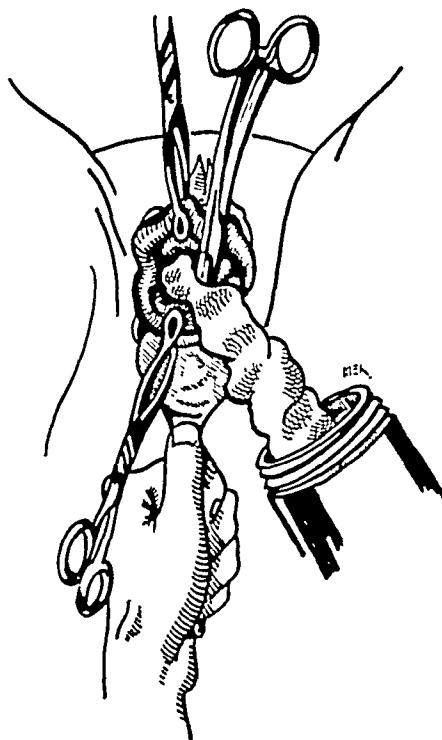


FIG. 3. Packing uterus by sight, instrumental. Sponge-holder forceps on each lip of cervix pull uterus down and straighten it. The assistant's hand controls the fundus to facilitate firm proper tamponade and to avoid perforation. (DeLee's "Principles and Practice of Obstetrics"—Saunders.)

*Atony of the Uterus.* Atony of the uterus may be due to primary or secondary uterine inertia. The etiology may be overdistension of the uterus from hydramnios, multiple pregnancy or an overdue large baby. Exhaustion from a prolonged labor is a factor also to be considered.

If hemorrhage occurs with the placenta still in the uterus, pituitrin should be administered, 1 cc. intramuscularly, and the fundus massaged. If there is no improvement, the placenta should be expressed during a contraction according to the Crede method. Failing in this, the physician should resort to manual removal. After the placenta is out and bleeding continues, the uterus should be massaged, pituitrin 1 cc. and ergonovine 1 cc. administered intramuscularly or .5 cc. pituitrin

intravenously. If the patient continues to bleed, the uterine cavity should be quickly explored for any remaining placental tissue

urinary bladder is emptied by means of a catheter. Posterior and lateral retractors and occasionally an anterior one are now

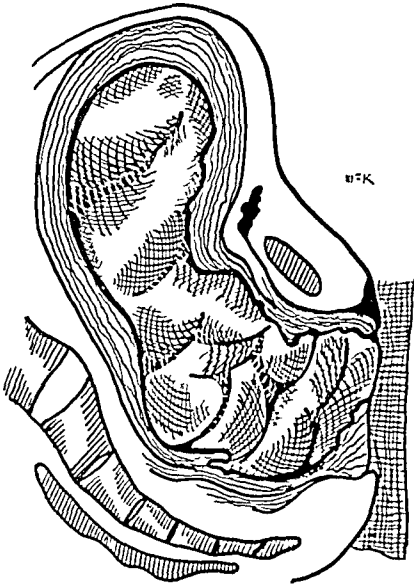


FIG. 4. A uterus correctly packed. (DeLee's "Principles and Practice of Obstetrics"—Saunders.)

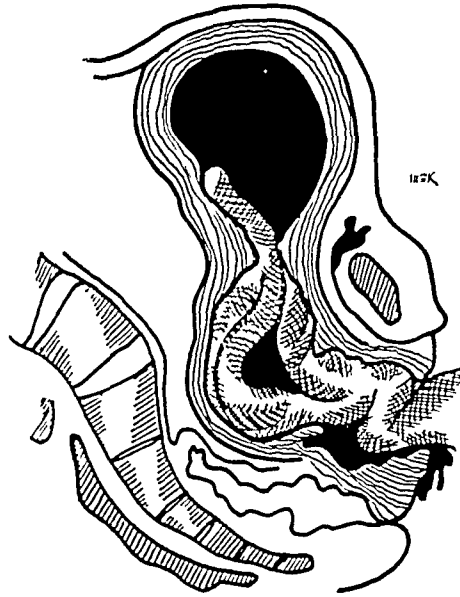


FIG. 5. A uterus incorrectly plugged. (DeLee's "Principles and Practice of Obstetrics"—Saunders.)

or membranes or for a placenta succenturiata, and if found removed, followed by immediate firm uterine packing.

Other methods which may be used are: (1) Ligation of uterine arteries; (2) clamping of uterine arteries; (3) sewing up the cervix tight over a plug (DeLee); (4) Sehrt aortic clamp; (5) manual compression of the abdominal aorta is of some value while other preparations are being made. This may be performed by the abdominal hand or with the hand in the uterus.

#### TECHNIQUE OF UTEROVAGINAL TAMPONADE

"Leroux invented uterine tamponade in 1776, Wendelstaedt wrote of it in 1806, but Dührssen popularized it in 1887."<sup>6</sup> In this procedure the first prerequisite is rigid asepsis, because hemorrhage lowers the body resistance against infection; the second is good exposure. The vulva, the inner surface of the thighs, the lower abdominal wall and the anal region are cleansed with ether and are painted with any of the newer antiseptic solutions. Fresh sterile drapes are applied. The

placed in order to expose the field. The anterior and posterior lips of the cervix are then grasped individually with sponge-holder forceps and brought down. (Fig. 3.) This type of forceps is used because it covers a wider area and does not tear the very friable tissue, as happens very frequently with the ordinary vulsellum forceps. The uterus is then packed firmly from above downwards using a curved uterine dressing forceps. The first portion of the gauze is carried well up to the fundus, which is steadied by an assistant's hand on the abdomen in order to avoid perforation. (Figs. 1 and 2.) In this respect Titus<sup>1</sup> stresses the importance of not removing the point of the packing forceps from the uterus, as is the tendency, but to withdraw it only a short distance grasping the gauze within the uterus and packing and folding it firmly from above downward. This is emphasized in order to avoid seizing the gauze outside the uterus and attempting to push the fold through the narrowed cervical canal, which usually results in an improperly packed uterus, namely, "an un-

packed uterus with a stoppered cervix." After the uterus has been properly packed, the continuation of the same gauze is used to pack the vagina, and as suggested by Beecham,<sup>7</sup> the lateral fornices should receive especial attention in order to cut down the uterine blood supply. It is sufficient to pack the upper two thirds of the vagina. A piece of black silk is then attached to the end of the gauze and the free end of the silk is held to the inner surface of either thigh by means of a small piece of adhesive tape one-half by one inch. This step in technic I have seen used by Phaneuf time and time again and it serves two purposes: It avoids the necessity of entering the vagina when the pack is to be removed and it prevents the possibility of contamination and spread of infection along the gauze from the outside to the vagina. (Figs. 4 and 5.)

Other methods of packing the uterus may occasionally be used such as tamponade with the hand in the uterine cavity, using the same hand to pack the gauze or using an instrument to pack the gauze while the hand is used to direct the gauze in the uterus.

The pack is removed in twenty-four hours and it is advisable to inject intramuscularly 1 cc. pituitrin and 1 cc. ergotrate about five minutes before the pack is removed in order to cause the uterus to contract firmly and thereby prevent further loss of blood. The gauze used may be plain, iodoform 5 per cent, or  $\frac{1}{2}$  per cent moist lysol gauze. The latter is recommended by DeLee. Various concerns put up this gauze in sterile sealed jars or tubes. The sizes vary, some use gauze one yard wide by five yards folded to a three inch width. Others have eight inch by ten yards folded

to a one inch width. Either size or type of gauze may be used.

#### SUMMARY

Severe uterine hemorrhages which require uterovaginal tamponade as one of the therapeutic measures are discussed under the following headings: Incomplete abortions, postpartum lacerations of the cervix, vaginal walls and rupture of vaginal varices, retained placenta with partial separation, inversion of the puerperal uterus, placenta accreta and atony of the uterus.

The outstanding symptoms in all of these conditions are hemorrhage and shock. It is emphasized that the hemorrhage must be controlled and the shock combatted before any other extensive operative procedures are instituted. In this regard it is noted that blood transfusions are excellent therapy for shock due to loss of blood, and should be used in addition to the other usual methods of shock treatment.

The technic of uterovaginal packing is described and illustrated, with stress on rigid asepsis.

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# LEUCORRHEA\*

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**E**XCESSIVE vaginal discharge is the chief "minor ailment" in gynecology. When this secretion is abnormal in amount, odor, color or causes itching or irritation, it may be assumed to be the symptom of some pelvic disturbance, either functional or organic.

## HISTORY

A careful history is of prime importance. Was the onset acute? Did it follow questionable sexual contact, or recent marriage? Is there burning micturition and vulval irritation? If these questions are answered in the affirmative, a gonorrheal infection is suggested. Is there itching and creamy or frothy discharge in a virgin? Or pruritus with dyspareunia in a married woman whose husband, is above suspicion? *Trichomonas vaginalis* or yeast infection is probably responsible. If the patient is pregnant, the probability of one of these latter conditions is increased.

## CHARACTER OF THE DISCHARGE

The appearance of the secretion often gives a clue to the etiology. A blood tinged discharge, especially in women over 40, means cancer until proved otherwise. Cervical polypi, submucous fibroids or hyperplasia of the endometrium may also cause a mucosanguineous type of leucorrhea.

A clear mucous, viscid or thin, milky, nonirritating issue, suggests erosion of the cervix, pelvic congestion or retrodisplacement of the uterus.

The trichomonads usually produce a frothy, bubbly or thick, creamy fluid; while the yeast organisms may form crust-like plaques on the vaginal wall. A cheesy, crumbly discharge may also result from a

monilia infection. A yellow discharge is often due to gonorrhea but may result from a nonspecific endocervicitis, senile vaginitis or pyometra.

A foul odor means either a foreign body or necrosis. Porous, soft rubber pessaries are old offenders and should never be used. Recently the writer removed a menstrual tampon that had been retained for several weeks, and a colleague found the same type of foreign body in a patient referred with a diagnosis of carcinoma of the cervix. Sloughing fibroids or cancer will also cause an offensive odor.

A sudden gush of pus from the vagina usually follows expulsion of an accumulation in the upper vagina. Rupture of an infected Bartholin gland or more rarely sudden evacuation of a pelvic abscess can produce the same effect. It is a common fallacy that pus tubes may drain suddenly into the vagina. This is impossible as the isthmus becomes occluded soon after the onset of salpingitis.

In infancy and childhood the discharge is usually confined to the vulva and lower vagina. The parts may be swollen, red and bathed in pus. A Neisserian infection should be carefully searched for, but more frequently yeast organisms or the common pyogens—*Staphylococci*, *Micrococcus cattarrhalis*, or *Bacillus coli*—will be found. Lack of cleanliness, a strongly acid urine, intestinal parasites, masturbation or a spread of infection from the respiratory tract should be considered.

## DIAGNOSIS

Careful inspection of the vulva, vagina and cervix with a thorough bimanual examination should reveal the source of

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the discharge. The urethra should be gently stripped under the symphysis and Skene's glands compressed. A loop of secretion should be taken from the urethra, vaginal fornix and cervix. Diluted with a few drops of saline solution this is studied under the microscope for trichomonads and yeast organisms. Staining for bacteria should then be done. A careful urinalysis should be performed in all cases, particularly when pruritus exists, to rule out glycosuria.

#### TREATMENT

If the gonococcus is found in an acute infection, the patient should be put to bed or hospitalized and a thorough course of the new chemotherapeutic drugs given. In the chronic cases the writer's results with these agents have not been so encouraging. In these the foci in Skene's glands, the urethra and endocervix must be eradicated. Whether the endocervicitis is specific or nonspecific, the deep racemose glands cannot be reached by topical applications; and if palliative methods fail, the infected endocervix must be destroyed by the electric cautery or removed by conization or the Sturmdorf operation.

As the endocervix is usually the source of the leucorrhea, vaginal douching merely removes the accumulated secretion and makes the patient comfortable for a time. In trichomonas infections, however, a true vaginitis exists and douching may effect a cure. Solutions for this purpose should always be nonirritating. Mild cases may respond to the popular vinegar douche (four tablespoons to two quarts warm water) or lactic acid (1 dr. to the quart) or 25 per cent salt solution. The patient should always be instructed to irrigate the vagina in a reclining position on a bed-pan or in the bath tub and a return flow douche-tip should be used. This has a rubber shoulder which fits snugly against the vulva permitting a thorough distention of the vaginal folds.

A variety of powders, tablets and suppositories has been developed for trich-

omonas vaginalis infection. These are particularly useful in pregnancy when douching is inadvisable. It is usually not possible to cure this type of infection during pregnancy but the symptoms may be relieved and the patient's comfort maintained. Treatment also controls the infection so that puerperal morbidity is not increased.

Stronger douche solutions such as mercuric chloride 1:4000 (best taken in the morning so that the fluid will not be retained), potassium permanganate 1:4000 or formalin 1 dr. to the quart, may be necessary in the more resistant cases. Infections that relapse repeatedly may have a bladder involvement that should be cleared up by urinary antisepsis. Making the urine strongly acid or alkaline kills the flagellates. If this fails, the writer has had excellent results with neo-prontosil tablets 5 gr. q.i.d. Skene's glands or the husband's prostate may harbor the organism.

Patients react differently to the various types of treatment developed for trichomonas vaginalis vaginitis. They all relieve the symptoms promptly but no method devised up to now will surely cure.

Yeast vaginitis usually responds promptly to a 1 per cent aqueous solution of gentian violet. The vaginal walls are thoroughly painted with this solution three times a week. Each morning an antiseptic douche such as hexylresorcinol 1:1000, merthiolate 1:1000 or metaphen 1:500 should be used. In the last month of pregnancy every effort should be made to cure the infection to prevent the development of thrush in the infant.

Leucorrhea caused by erosion or laceration of the cervix may be temporarily relieved by an astringent solution. An excellent one for this purpose is compound zinc powder (N.F.) 1 dr. to the quart. The cautery should be used to cure erosions and to assist in the epithelialization of minor lacerations. When the latter are extensive, a trachelorrhaphy or amputation of the cervix should be done.

## SUMMARY AND CONCLUSIONS

Although leucorrhea may be classed as a *minor* ailment, it is frequently a *major* annoyance to the patient. A search for the cause and cure will frequently tax one's diagnostic ability and therapeutic ingenuity. A form of treatment which

relieves one patient may not help another with a similar condition. It should be borne in mind that in most cases of long standing leucorrhea, the fons et origo of the discharge lies in the endocervix. No cure can result until this infected tissue is destroyed or removed.



IN obtaining cultures from the more accessible portions of the female tract, such as the urethra, cervix, vulva or vagina, it is well to remove surface material and obtain the cultures direct from the membrane itself. From—"Office Urology" by P. S. Pelouze (W. B. Saunders Company).

# NON-INFLAMMATORY NODULES IN THE FEMALE BREAST\*

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AS the lay public becomes increasingly tumor-conscious, physicians are consulted by many patients complaining of nodules of the breast and thyroid, lesions of the face, trunk and extremities which cause worry because of the possibilities of cancer. Obviously, public education serves the admirable purpose of bringing to the physician's care lesions at any early and perhaps curable stage. In the past, the diagnosis and palliative therapy in cancer was simple, since the overwhelming majority of cancer patients came under observation during the advanced stages of the disease. This state of affairs is now changed. Practitioners are seeing an increasingly large proportion of lesions at so early a stage that their nature is often in doubt. Intelligent handling of these early cases demands an intimate working knowledge of the basic pathologic changes to which these tissues are subject. This paper is an attempt to present in a simple and workable fashion the fundamental pathologic principles that are essential to the rational treatment of the non-inflammatory breast lesions. Clinical pictures will be discussed only to correlate with their pathologic basis. Therapy will in most cases be only mentioned.

The mammary glands, each composed of twelve to fifteen glands, function by producing secretions which are carried through a duct system to the nipple. Structurally each of these glands is composed of a large duct, its branches, and the terminal ducts and acini. The functioning unit or acinus is lined by a layer of cuboidal epithelial cells directly under which is a layer of loose subepithelial fibrous tissue.

A single layer of smooth muscle cells surrounds the subepithelial layer and separates it from the more abundant periductal and periacinar connective tissue that surrounds the glandular clumps and serves to define them from the coarse collagenous fibrous stroma of the breast. Grossly the normal adult breast then is composed of fat and pearly white fibrous stroma stippled with slightly raised salmon-pink bodies. The latter are the functioning gland groups of ten to twenty acini. Until puberty this gross picture is modified because the parenchyma consists only of ducts.

Physiologically the proliferative and secretory activities of the breast are apparently under the control of the corpus luteum of the ovaries and the placenta hormones. At puberty under the influence of the functioning ovary the breast tissue undergoes a proliferative phase that is identical with the more exaggerated process that occurs in pregnancy. This physiologic proliferative process is frequently the cause of the breast discomforts of puberty, menstruation and pregnancy.

With this knowledge of breast structure and activities in mind, it is apparent that the large percentage of non-inflammatory breast nodules are only abnormal reactions of epithelium and connective tissue. These may each be considered under their hyperplastic and neoplastic reactions.

## EPITHELIUM

1. *Desquamative Epithelial Hyperplasia.* The energies of breast epithelial cells are divided into performing their secretory functions and reproducing. If the reproduc-

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tive activities are excessive but within normal limits and the epithelium retains some function and is not infiltrating, the epithelium is considered hyperplastic. This hyperplasia of breast epithelium is frequently termed desquamative epithelial hyperplasia because many of the cells are performing their normal function of desquamation into the lumen. Desquamative epithelial hyperplasia with new duct and acini formation, accompanied by a hyperplasia of the mantle of periacinar and periductal connective tissue and lymphocytic infiltration is a normal physiologic proliferative process *only* at birth, puberty, menstrual periods and pregnancy. If this normal proliferative process occurs at any other time the condition is termed chronic mastitis. Because this term implies the misconception that the condition is fundamentally an inflammatory one Cheatle and Cutler<sup>6</sup> have recommended substituting the term *mazoplasia*.

A second disease entity that is primarily a desquamative type of epithelial hyperplasia and accompanied by the same changes noted above differs in that the biologic activity of the epithelial cells does not end with desquamation but goes on to cyst formation. This condition, which is never physiologic or inflammatory in origin, is usually called chronic cystic mastitis. Cheatle and Cutler have suggested the term *cystiphorous desquamative epithelial hyperplasia*.

(a) *Chronic Mastitis or Mazoplasia*. It has been noted that this completely benign condition is fundamentally a normal physiologic proliferative process occurring at an abnormal time. The biologic activity of the epithelial cells in this condition is limited to desquamation. The correct diagnosis of chronic mastitis or mazoplasia positively excludes the presence of cysts and papillomas, and the condition is never a precancerous lesion. Mazoplasia or chronic mastitis is almost universally present in the same breast with papillomas, carcinomas, or cysts, but careful search by many investigators has failed to reveal any

microscopic indication of a transformation of the desquamative epithelium into neoplastic or cystic conditions.

The outstanding subjective symptom is a diffuse aching pain over one or both breasts that is often exaggerated at the time of menstruation. Many of the patients have short, scanty menstrual periods as additional evidence of domination of the corpus luteum. There is no interference with the normal contour of the breast. To palpation, the gland is wholly or in part more solid than usual, and often a fine nodularity is detected throughout. There is no nipple discharge.

Treatment is primarily the positive diagnosis of the condition and exclusion of other lesions, by biopsy if necessary. Palliative therapy consists of rest, mechanical support, and ovarian substances, as ovarian residue, etc., to counteract the dominating control of the corpus luteum hormone. *Prolonged hopeful medical treatment of the suspected breast nodule without accurate biopsy diagnosis is extremely hazardous and ill advised.*

(b) *Chronic Cystic Mastitis or Cystic Disease of the Breast (Cystiphorous Desquamative Epithelial Hyperplasia)*. In this second type of desquamative epithelial hyperplasia, the biologic activity of the hyperplastic epithelial cells is not completely spent in desquamation but tends to cyst formation. Chronic cystic mastitis may coexist with the rather universal chronic mastitis, but is entirely separable in its etiology, symptomatology, pathology, prognosis and treatment. The clinical importance of chronic cystic mastitis is intimately concerned with the possible complications of the cyst, e.g., stagnation and tumor formation.

The possible relationship between cystic disease of the breast and cancer is obviously of great import, but is highly controversial. Delbet<sup>10</sup> and Bloodgood<sup>1</sup> represent a large body of surgical opinion in stating that the condition is too benign to justify extirpation and that the association between chronic cystic mastitis and carci-

noma is very rare. This conclusion is based on their observations that characteristic cases pursue a chronic course without any neoplastic complication.

Against this view stands the interpretation of the majority of pathologists, including Cheatle and Cutler,<sup>6</sup> Ewing,<sup>12</sup> Schimmelbusch,<sup>15</sup> and Boyd<sup>3</sup> that the character of the tissue change in chronic cystic mastitis is such that the change to carcinoma is easy. Advocates of this viewpoint feel that cystic disease of the breast should be considered and treated as a highly important precancerous lesion. Cystic formation predisposes to stagnation of the contents of the ducts and acini. Irritating stagnant contents may, if undisturbed over a period of years, lead to an irritative hyperplasia of the lining epithelial cells or to a benign neoplasia (papilloma). Cystic disease of the breast with papilloma formation has been termed Schimmelbusch's Disease. The step from a benign neoplasia (papilloma) to a malignant neoplasia (cancer) does occur in some cases.

Not all cases of cystic disease of the breast pursue this course of events. The disease *may become arrested* at the cystic or papillomatous stage, or may actually regress. The frequency with which this disease *may* progress to the benign and later malignant neoplasia stage is difficult to estimate, but is approximated at 10 to 15 per cent. Cheatle and Cutler conclude from a study of their material that 20 per cent of the cancers of the breast arise by this sequence, e.g., progressing from cysts to papillomas to carcinomas. Ewing<sup>12</sup> and Verga<sup>16</sup> state that about 50 per cent of their cases of chronic cystic mastitis show pronounced precancerous changes or miniature carcinomas.

The disease usually develops in one breast and often later in the other. The onset and progress are slow and often painless and the condition may not be recognized until a cyst of some size attracts attention. There may be a golden brown or green black fluid discharged at the nipple. A bloody nipple discharge usually, but

not always, indicates a papilloma or carcinoma. The examiner finds that the breast of such a patient may contain numerous cordlike structures and multiple swellings with great irregularity of structure. Transillumination, as suggested by Cutler,<sup>7</sup> may infrequently substantiate the impression gained by physical examination that the condition is a cystic disease of the breast.

The clinical distinction between uncomplicated cystic disease of the breast, cysts with papillomas or carcinomas, and carcinoma of the breast, is often extremely difficult. Usually biopsy and frozen section examination are necessary. At surgery the entire suspicious region should be removed wide of the lesion. Grossly the tissue in chronic cystic mastitis will present a pattern of dirty gray or bluish gray firm fibrous tissue studded with cysts. The cysts may be small and numerous, or large and infrequent. From the smaller cysts worm-like putty, gray casts (butter cysts) may be expressed. Large cysts when unopened may have a bluish tint that suggested to Bloodgood the term blue-domed cyst. The contents of the large cysts may be clear straw-colored fluid or much caseous fatty material. Especially should the clinician and pathologist examine the tissue for unusually firm, pearly gray, finely granular regions—indications of malignancy.

Further treatment of the condition, if no cancer exists, has been well discussed by Cutler and Buschke.<sup>9</sup> They feel that the decision must be made in each case and guided by individual factors, such as family history of carcinoma of the breast, the patient's attitude in wishing to accept the *possibilities* of breast cancer rather than mastectomy, etc. The patient's coöperativeness and opportunities for periodic postsurgical "check-up" examinations of the breast are additional factors influencing the surgical course. Cystic disease of the breast with localized papilloma formation (Schimmelbusch's disease), often termed cystadenoma, is considered an indication for local mastectomy because of the ease of transformation to cystadenocarcinoma.

11. *Epithelial Neoplasia.* If the reproductive activities of the breast epithelial cells are excessive, remaining viable and capable of further reproduction instead of performing their primary function of desquamation, the epithelium is considered to be neoplastic. Frequently this distinction between hyperplastic and neoplastic epithelium is extremely difficult. The further differentiation of benign from malignant lesions is and should be based on a combination of the clinical and histologic findings. In the usual case it cannot be emphasized too strongly that the microscopic findings should be interpreted only in the light of the clinical picture. In some cases the microscopic findings are all-important and alone establish the diagnosis, prognosis and treatment. In other cases, however, they must be discarded in favor of the clinical data; Ewing's expression, "microscopically malignant, clinically benign" illustrates this concept neatly.

Cheatle has declared that the only absolute microscopic evidence of carcinoma of the breast is the presence of actively multiplying cells outside their normal boundaries of ducts and acini. Epithelial cells with all the morphologic characteristics of malignancy but which are still confined within normal boundaries are, according to Cheatle, to be considered as precancerous lesions.

*Benign Epithelial Neoplasms. (a) Papilloma.* The simplest papillomas are benign tumors composed of stalks of vascular connective tissue covered by epithelial cells. They may occur in the ducts or acini, but duct papillomas with stalks of periductal connective tissue are most frequent. Those with a single stalk are termed uniradicular, those with multiple stalks, multiradicular. There is a tendency for all papillomas to develop alveoli of various shapes in an attempt to create new glandular elements of duct and acini. These, depending on their appearance, are qualified as adenopapilloma, intracystic papilloma, etc. A more important type of papilloma in

its precancerous capabilities is the sessile variety in which there is a piling up of cells in a papillary formation.

These soft yellowish tumors vary markedly in size and consistency. Studies of whole microscopic sections of the breast disclose the fact that these tumors are more frequent than is generally supposed and are frequently multiple. If only a single papilloma is present it is usually found in the duct of the nipple, ampulla, or one of the large main ducts. Multiple tumors are usually unilateral but occasionally they may occur in both breasts.

The classical clinical sign is a serous or serohemorrhagic nipple discharge. Usually this discharge is intermittent and frequently confused with the similar discharge from trauma or carcinoma. Pain is a frequent symptom if hemorrhage distends the duct. A palpable tumor is now rarely found because patients are first examined at the time of early nipple discharge. Gentle pressure and transillumination are the methods used to localize the lesion.

As in papillomas of the colon and urinary bladder, carcinoma may supervene on papillomas of the breast, but increasing evidence indicates that the time interval of this malignant change may be extremely long. Since there is no clinical method of determining whether or not the malignant transformation has already occurred, or to predict its time of occurrence, all papillomas of the breast should be regarded as potentially malignant. The extreme view, according to some surgical pathologists, is to regard the whole breast containing a papilloma with suspicion. Cutler and Buschke<sup>9</sup> summarize treatment, using a composite of many criteria, including the degree of anaplasia of the cells in the removed specimen, the age of the patient, history of cancer in the family, findings of transillumination, size of the lesion, psychologic reaction of the patient to breast amputation, etc.

(b) *Adenoma of the Breast.* Pure adenomas of the breast are extremely rare and are merely mentioned here. They are

composed almost entirely of glandular elements and are frequently described as "fetal adenomata." Their course resembles that of the fibroadenomas except that they may be first noted as rather rapidly enlarging benign tumors during pregnancy. Frequently they are only diagnosed histologically in a tumor removed as a fibroadenoma.

2. *Malignant Epithelial Neoplasia—Cancer of the Breast.* In spite of the frequency, accessibility, and importance of breast cancer, progress in this field is extremely slow and discouraging. Surgeons and pathologists alike are so bewildered by the variety of anatomic and histologic patterns of the disease, and by the varying clinical courses individual cases may pursue, that too frequently the whole group is classed together, as carcinoma of the breast. Equally less illuminating are the older attempts to classify the malignant epithelial lesions into carcinomas of the solid, simplex, medullary, and scirrhus types.

Chief among the difficulties in any rational grouping of these lesions is the fact that once the tumor has begun to spread within the breast numerous events alter its morphologic and microscopic appearance. The urgent need is for a classification based on anatomic and histologic types which physicians can associate in some way with the clinical types, considering frequency, course, prognosis, and the therapy indicated. Ewing<sup>12</sup> and Cheate<sup>6</sup> have done important pioneer work in this field by offering just such a classification—admittedly not perfect, but at present the best offered. For a more complete consideration of this subject, reference should be made to the works of Cheate and Ewing.

Carcinomas of the breast may arise in one or more of four primary locations: (1) in the main branch of the duct near the nipple; (2) in the midportion or the duct unit, that is, in one of the smaller branches; (3) in a terminal duct and acinus; and (4) in the entire duct system.

The primary tumors in each of these

locations may be modified in their clinical, pathologic, and histologic features by any of four events in varying degrees, namely: *anaplasia*, *gelatinous* or *mucoïd degeneration*, *fibrosis*, and *comedo formation*. It is interesting to note that in a general way the malignancy of breast cancers increases as one goes peripherally from the nipple.

(a) *Papillary Adenocarcinoma of the Breast.* These are the large, firm, often encapsulated, growths in a large duct behind or near the nipple. Frequently they are thought to arise in a cyst that over a long time period has passed through the papilloma stage to the malignant one. In later stages these cysts frequently occupy a large portion of the breast, but still without lymph node metastasis. Important clinically is that in the later stages of the disease there is a marked discrepancy between the apparent seriousness of the disease and its comparatively favorable prognosis.

(b) *Carcinoma Developing on the Basis of Cystic Disease and Schimmelbusch's Disease.* The relative frequency of this type has been noted by some authors<sup>7</sup> as approximately 20 per cent of all carcinomas of the breast. Ewing<sup>12</sup> states that the majority of mammary carcinomas present themselves under these situations.

Cheate<sup>6</sup> separates this type into two subgroups. The first usually arises from one duct and its acini, and demonstrable cystic disease of the breast, generally complicated by papillomata formation (Schimmelbusch's disease), is present. At some region in this mass of cysts and papillomas, carcinoma may develop. These patients usually give a long history of cystic disease and frequently have undergone one or more operations for the removal of such cysts. Often there is a history of nipple bleeding due to duct papilloma. Finally the clinical and pathologic evidence of the supervention of carcinoma is noted.

In the second subgroup, cystic disease may or may not be present. The carcinoma develops in a terminal duct and its acini, with no predilection for previously altered

tissue. These tumors are usually small, firm, opaque, and extremely malignant. They belong to the so-called anaplastic type of carcinoma. In these cases the history is short. There may be no evidence of preëxisting cysts or bleeding from the nipple, without gross or microscopic evidence of a precancerous state. Because of its frequency in young patients the lesion is often misinterpreted as benign.

(c) *Diffuse Duct Carcinoma*. In this variety the epithelial lining of several ducts and frequently the entire duct system are involved in the neoplastic process. The breast is enlarged and diffusely indurated. In the advanced stages, the skin, nipple, and whole mammary gland may be markedly thickened. To palpation there may be no discreet tumor mass. This is a highly malignant form of mammary carcinoma with early invasion of lymph nodes and a consequently unfavorable prognosis.

In the *comedo* variety of duct carcinoma the mammary gland undergoes a diffuse fibrosis with considerable shrinkage. Grossly the entire duct system is involved, but dilated ducts are filled with necrotic debris. Microscopically the lining epithelium is neoplastic but the lumen is distended and filled with degenerating epithelial debris. Bloodgood particularly recognized the relatively benign nature of this form of mammary cancer.

Surgery continues to occupy a prominent place in the treatment of mammary carcinoma. As patients consult their physicians earlier the proportion of clinically doubtful tumors increases, with the indications for exploratory operations correspondingly increased. Diagnostic biopsies in dealing with practically all tumors should, when practical, be replaced by therapeutic biopsy, in which the entire lesion is gently removed with adjacent healthy tissue. In many carcinomata radiation therapy is combined with the radical surgical procedure and in exceptional instances may be substituted for it.

Ewing summarizes nicely the general feeling that the chief hope for a reduction

in the mortality from mammary cancer lies in its prevention and earlier diagnosis. He feels that both these objectives point to the excision of many breasts before carcinoma has become established in the clinical sense. The growing tendency to remove the breast for recognized chronic cystic mastitis, Schimmelbusch's disease or suspected carcinoma, while probably sacrificing some organs unnecessarily, has justified itself in his opinion by securing the early removal of some miniature carcinomas and more precancerous lesions.

Under the malignant neoplasias one may also discuss the interesting disease entity described by Paget<sup>14</sup> in 1874, and designated as Paget's disease of the nipple. This clinical syndrome is distinct and classical, but the underlying nature of the pathologic process is highly controversial.

Paget originally described the process from clinical observation alone as a superficial lesion that is often followed by a carcinoma of the underlying breast tissue. More recent studies by Muir<sup>13</sup> and Shaw Dunn<sup>11</sup> have led to the opinion that carcinoma in the upper ducts is commonly present when the disease first comes under observation, in which case carcinoma does not follow, but causes the surface disease.

Paget's disease of the nipple is unilateral. It begins on the surface of the nipple as a chronic, slowly progressive, eczematous, often dry, red and scaly lesion. It spreads slowly to involve the areola and finally causes a flattening of the nipple. Axillary glands are practically never involved until late in the disease. Carcinoma of the underlying breast almost invariably accompanies the surface lesion although frequently difficult to detect by clinical methods.

Characteristic of this condition histologically are the edematous vacuolated neoplastic Paget's cells found in the epidermis, the malignant-appearing neoplasia of the epidermis of the nipple, and the adjacent large ducts in some of which frank cancer may be present.

Treatment is as debatable as the nature of the underlying pathologic process. Since

one can never be sure clinically of the condition of the axillary glands, Cheatele and Cutler and Bloodgood are emphatic in their opinion that radical mastectomy is the only treatment to be employed. Others feel that if there is no gross disease of the axillary glands local mastectomy is curative.

#### CONNECTIVE TISSUE

The abnormal reactions of connective tissue may similarly be considered under their hyperplastic and neoplastic reactions. Connective tissue hyperplasia affects the breast diffusely and there is no localized growth. Important hyperplasia of connective tissue has been considered in connection with the epithelial hyperplasias.

Connective tissue neoplasia of the breast is a localized process, usually with a decided epithelial element. These neoplasias are subdivided into the benign and malignant varieties.

##### 1. *Benign Connective Tissue Neoplasia.*

(a) *Fibroadenoma.* These are benign, usually encapsulated, connective tissue tumors with a decided epithelial element. Pure fibromas of the breast are a rarity. Fibroadenomas are classified into the subepithelial intracanalicular fibroadenomas, and the pericanalicular and periacinar types, depending on the region of origin of the connective tissue element. Tumors having both subepithelial and periacinar and periductal connective tissue constituents are usually classified as mixed tumors.

Clinically these tumors are very common and are frequently present without clinical signs. Rarely do they develop before puberty. Between puberty and the age of 25, they are usually of the periductal and periacinar types, constituting the most common tumor of the female breast. They are firm, round, solid, often lobulated, freely movable and well circumscribed nodules. The rate of growth varies. Rarely do they cause pain. They may become extremely large by direct growth or cystic changes, and by malignant sarcomatous transformation. The latter is thought to

occur in about 5 to 8 per cent of the cases. Rapidly growing fibroadenomas frequently appear microscopically malignant but are clinically benign as proved by absence of metastases and survival of the patient.

Treatment is their surgical removal. All such operations should be performed with the thought in mind of the possibility of an error in diagnosis.

II. *Malignant Connective Tissue Neoplasia—Sarcoma.* Sarcoma of the breast constitutes approximately 4 per cent of the breast tumors. This apparently high estimate is probably accounted for by the fact that in the past many highly anaplastic carcinomas have been incorrectly considered as sarcomas. The most common type of sarcoma of the breast is that in which the malignant transformation of the connective tissue is accompanied by epithelial elements, adenosarcoma. Pure sarcoma of the breast without any epithelial elements is extremely rare.

(a) *Adenosarcoma.* The ultimate character of an adenosarcoma of the breast depends largely upon whether the connective or the epithelial elements assume the leading and dominating rôle. The largest sarcomas are those in which the epithelial changes are marked. Microscopically the connective tissue is frequently myxomatous. Clinically it is a disease of later life, usually occurring between the ages of 40 and 50 years. The spindle-cell variety develops earlier in life than the round-cell type. The first clinical sign is usually a single breast nodule, or, more rarely, multiple nodules in one breast. Pain is a late symptom and more common in the cystic forms with epithelial activity. Nipple discharge is infrequent.

A chief characteristic of sarcoma of the breast is a tendency to local recurrence. The axillary glands are rarely invaded, distant metastases being more common.

Treatment consists of surgery and radiation. The prognosis varies with the type, the cystic forms being less malignant than the solid variety. Radiation is of most value when the tumor is composed of round cells.

(b) *Pure Sarcomas.* These breast tumors are extremely uncommon and clinically indistinguishable from adenocarcinoma of the breast.

#### MISCELLANEOUS TUMORS OF THE BREAST

Tumors occasionally found and only to be mentioned are: any of the benign or malignant tumors of the epidermis, sebaceous, and dermoid cysts, lipomas and angiomas.

#### SUMMARY

1. Intelligent handling of the non-inflammatory breast nodules in the female breast demands an intimate working knowledge of the basic pathologic changes to which this organ is subject.

2. An attempt has been made to present in a simple and workable fashion the fundamental pathologic changes of the non-inflammatory breast nodules in the female breast.

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# A CONSIDERATION OF UTERINE PROLAPSE AND RELATED CONDITIONS\*

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## GYNECOLOGIC HERNIAS

IT is important to recognize that uterine prolapse, cystocele, urethrocele, enterocele and rectocele are all hernias, and that in their treatment one must follow the same surgical principles employed in the repair of hernias elsewhere in the body.

Gynecologic hernias occasionally develop in nulliparous women as the result of congenital weakness of the pelvic muscles and fascia, and an exceptionally deep cul-de-sac of Douglas; but for practical purposes, the causative factors may be considered to be the stretchings and lacerations incident to parturition and increased intra-abdominal pressure. As in the treatment of all hernias, the most satisfactory time to repair those of a gynecologic origin is as soon as possible after they occur, before muscles and fascia retract and become atrophied from lack of use. In other words, few gynecologic hernias would develop and few extensive operations would be required for procidentia and related conditions if injuries incident to childbirth were repaired at the time of occurrence or soon afterward.

I often hear a woman say that she knew she was lacerated at the time of her first labor, but that her doctor at home had advised against any surgical intervention until after she had definitely decided to have no more children. If a few well placed stitches could be inserted after each labor complicated by lacerations, few radical or extensive operations would be required in women at or past the age of the menopause. There is no doubt that obstetricians today realize the importance of puerperal

gynecology, but Richardson has stated that "Recent reports from some of our best obstetrical clinics reveal that late follow-up examinations disclose unsatisfactory conditions of the cervix and lower birth canal in from 50 to 75 per cent of women who have borne one child or more."

Arriving at a diagnosis of gynecologic hernia is not all that is necessary in advising treatment. We must also have some idea of the size of the hernia; grading it in degrees from 1 to 4, as its size indicates, is a genuine aid. In many cases in which the protrusion should be graded 1, no treatment is indicated, because many of these hernias change but little as time passes; however, if the patient is examined again after one year's time and the cystocele, descensus uteri or rectocele can at this time be graded 2 or 3, such an increase would constitute definite evidence that the hernia is a progressive condition and that nothing could be gained by delaying treatment.

## CAUSATIVE FACTORS IN URETHROCELE, CYSTOCELE, RECTOCELE AND UTERINE PROLAPSE

Urethrocele and cystocele are the result of lacerations of the anterior vaginal wall involving the urogenital diaphragm; they are also caused by lack of support as the result of stretching or tearing of the perineal body or the levator ani muscles. Rectoceles are the direct result of lacerations of the posterior vaginal wall involving the levator ani muscles or the perineal body; they may become large even when there is little or no injury to the skin of the perineum.

\* Read before the third annual meeting, New Orleans Graduate Medical Assembly, New Orleans, February 6, 1939.



Uterine prolapse is the result of lacerations of either the anterior or posterior vaginal wall, or more frequently of both,

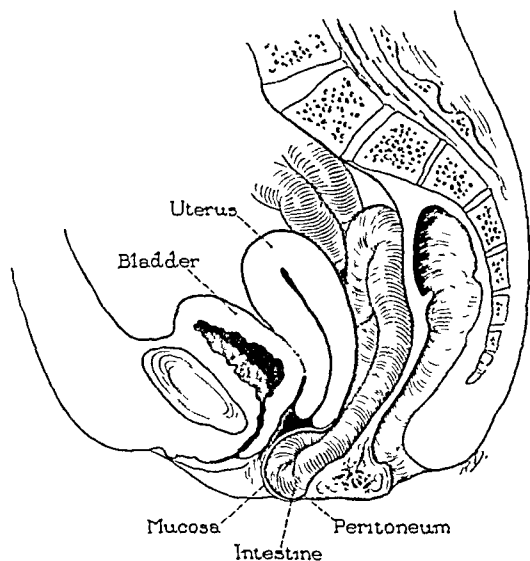


FIG. 1. Posterior vaginal hernia or enterocele (true gynecologic hernia), showing presence of a definite peritoneal sac.

associated with tearing and stretching of other uterine supports, especially the cardinal or Mackenrodt ligaments. Retro-displacements of the uterine fundus always hasten descensus; in fact, neglected cases tend toward the development of procidentia, which is a condition of prolapse in which the entire uterus extrudes from the introitus vaginae. In many cases of descensus uteri, and particularly in cases of procidentia, undesirable changes take place in the uterus. These changes are especially evident in the cervix uteri, where they are usually the result of hyperplasia and edema, caused by venous congestion and infection. In many cases in which the cervix protrudes through the introitus vaginae, ulcers develop as the result of irritation arising from rubbing on the skin of the thighs, or from vulvar pads. Although malignancy has been reported accompanying or proceeding from some of these rather common ulcers, it is a change rarely encountered.

#### THE TRUE GYNECOLOGIC HERNIA

All the conditions heretofore considered are actually false abdominal hernias be-

cause there is no peritoneal sac present to characterize them as true hernias. An enterocele, however, is a true hernia. (Fig. 1.) It may be either anterior or posterior in situation, depending on its relation to the uterus. Anterior enteroceles are rare; when they occur, there is a sac of peritoneum descending along the anterior vaginal wall between the vaginal wall and the bladder. I have never seen one. Posterior enteroceles are relatively uncommon, but they occur much more frequently than most physicians and surgeons suppose. Many of the supposedly recurrent rectoceles are in reality posterior enteroceles, and on careful dissection, a peritoneal sac can be demonstrated descending between the rectal wall and the posterior wall of the vagina. Since 1925, when the condition of posterior enterocele was first recognized as a surgical entity at The Mayo Clinic, we have seen eighty-eight cases. Anterior enteroceles can be diagnosed by vaginal examination, using a sound in the bladder; posterior enteroceles are easily recognized by making a combined vaginal and rectal examination.

In the beginning, I mentioned that intra-abdominal pressure as well as lacerations of the muscular and fascial planes was a causative factor in producing gynecologic hernia. There is no doubt that the development of all types of gynecologic hernias, in common with the development of abdominal hernias, is hastened by anything that increases pressure from within the abdomen, such as obesity, tendency toward constipation, intra-abdominal tumors, coughing, sneezing, straining at stool or at heavy work, and simply the patient's being in the erect position for long periods of time.

*Uterine Prolapse.* Many women have uterine prolapse to a greater or lesser degree, but attend to their usual household and social duties with little or no complaint. Others experience definite symptoms arising from relatively slight anatomic changes. As a rule, uterine prolapse is accompanied by cystocele of some degree, and it is the

symptoms produced by the protruding bladder when it is incompletely emptied, and the resulting infection, that first bring

the normally strong levator ani muscles contract and provide definite support for the anterior vaginal wall in compensation

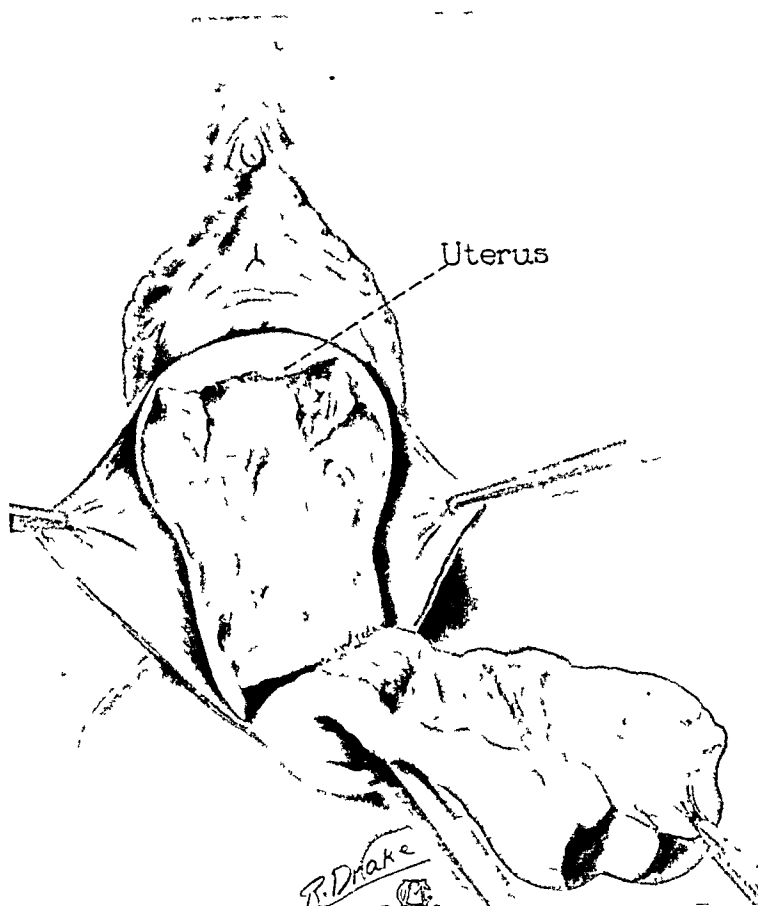


FIG. 2. Modification of the Watkins-Wertheim operation for prolapsus uteri and cystocele, with removal of considerable portion of the uterus, including all the endometrium and cervix.

these patients to the gynecologists. In the presence of an extreme degree of cystocele, hydroureterosis occasionally results, as well as hydronephrosis caused by distortion of the base of the bladder, and ureteral obstruction as the result of traction at the vesical end of the ureters. In evaluating disorders of the urinary tract, the physician must ever keep in mind the possibility of a neurologic cause, and realize that in such cases, gynecologic surgery is not indicated.

**Rectoceles.** Grade I rectoceles are common in women who have had multiple deliveries. As a rule, these rectoceles produce little trouble, but the gynecologist must ever keep in mind the fact that the normal vagina is a closed canal, and that in the occurrence of strain from any cause,

for the increased pressure from above, thus protecting against the development of cystocele and uterine prolapse. But if the levator ani muscles are torn or if the perineal body is disrupted, this support for the uterus and bladder is lost, and a vicious tendency toward the production of anatomic changes is present. Furthermore, as a rectocele gradually increases in size, a definite pouch develops in the anterior rectal wall; this pouch protrudes through the vaginal introitus and bulges over the internal sphincter ani. This interferes markedly with emptying of the bowel and patients having this condition soon find that it is necessary to depress the posterior vaginal wall before a bowel movement is possible.

*Enteroceles.* Enteroceles, or true vaginal hernias, result from lacerations of the supporting fascia, either in front or behind the

women. The use of some type of pessary often gives definite relief to women who are suffering from cystocele, uterine pro-

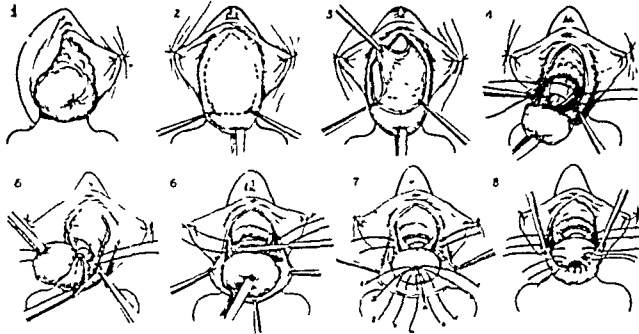


FIG. 3. Various stages in the Manchester (Fothergill) operation for prolapsus uteri and cystocele.

uterus just below the level of the peritoneal reflection. Most of the patients having enterocele that I have seen have had previous perineorrhaphies performed, a fact which makes it impossible to say whether the injuries predisposing to the condition were the result of lacerations at the time of childbirth, and that the peritoneal sac was not recognized at the time perineorrhaphy was done, or that the condition developed subsequent to the perineorrhaphy as the result of making an opening into the cul-de-sac of Douglas, or at least up to the peritoneum, with inadequate closure at that time.

*Palliative Treatment.* Surgical repair is indicated in most cases of extensive vaginal herniation. Many women, however, who do not have marked symptoms and are contemplating the birth of more children, prefer to delay surgical intervention even at the risk of undergoing a more radical operation at a later date. In the case of some debilitated, elderly women, there is a definite contraindication to surgical intervention of any type.

If surgical intervention is not indicated or if it is refused by the patient, the advisability of using nonsurgical measures, such as the insertion of tampons and pessaries, must be considered. Tampons are often the most satisfactory means of retaining a prolapsed uterus with associated cystocele and rectocele in elderly

lapse and high rectoceles. If the perineum has been extensively lacerated, however, it is usually difficult to fit a pessary so that it will be comfortable for the patient, and yet remain in place.

No one type of pessary is satisfactory in all cases. The ones most useful probably are the simple ball type, the doughnut type, the Menge, the Gehrung and the Gellhorn types. They all tend to produce leucorrhea, and unless the patient can remove and re-insert them herself, they are not practical. Allowing them to remain in place over long periods tends to cause irritation and ulceration. Daily douches are always advisable when pessaries are being worn and patients must recognize the fact that the wearing of a pessary does not cure the condition. It simply prevents further tendency to procidentia.

#### SURGICAL TREATMENT

*Indications.* The type of operation indicated varies with the extent of the herniation, and the personal experience and judgment of the surgeon; also, with the age of the patient and her marital state. The relative dangers of an abdominal or vaginal operation, and the severity of the symptoms must be carefully considered in each case. Any routine type of operation must be condemned, because it certainly would be too radical in many cases and insufficient in others. In some cases in

which a slight urinary incontinence is caused by minor laceration of the vesical sphincter and is possibly accompanied by causative factor in the production of gynecologic hernias is a lacerated levator ani muscle, and that a perineorrhaphy is

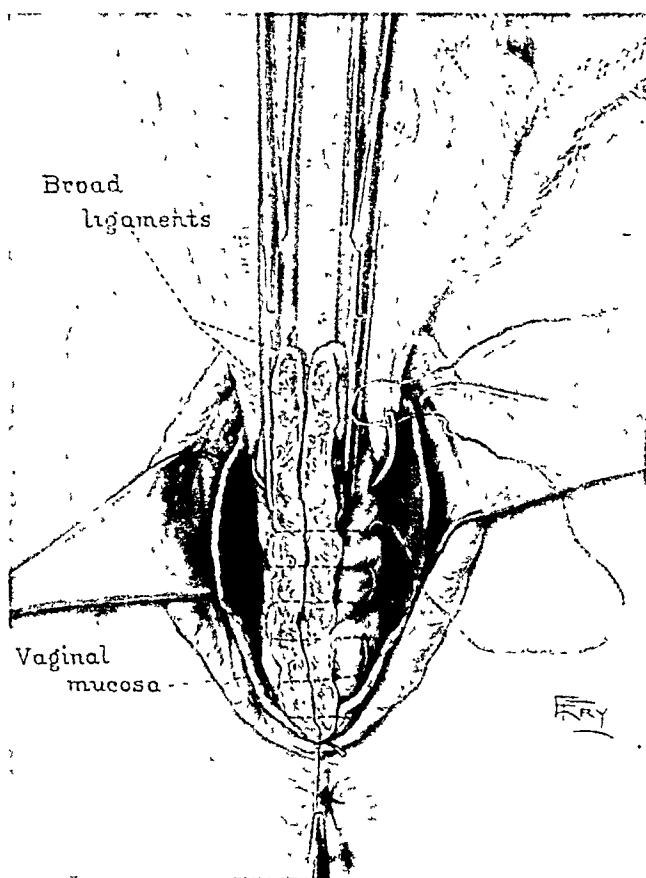


FIG. 4. The Mayo operation for prolapsus uteri and cystocele. Uterus removed. Broad ligaments approximated. Later, the broad ligaments are interposed beneath the bladder in the same manner as the uterus is in an interposition operation.

a small urethrocele, a few well placed sutures after an adequate freeing of the anterior vaginal mucous membrane is all that is necessary to obtain a good result. In case of the presence of a definite cystocele, a more radical operation is indicated, because almost all such cystoceles tend to protrude more and more as time passes. In many instances, simply freeing the bladder, fixing it at a higher level on the anterior uterine wall; a more or less extensive reconstruction of the muscles and fasciae in the anterior vaginal wall; and removal of an elliptical piece of the stretched-out vaginal mucous membrane, will produce good results. But it must be borne in mind that an important

an essential reparative procedure in all cases. If the retrodisplacement of the uterus also exists, some type of internal shortening of the round ligaments or fixation of the uterus, should be done at the same time.

*Interposition Operation for Cystocele.* In many cases of grade 2 or 3 cystocele, in which there is uterine prolapse of no more extent than grade 2, the interposition operation (Watkins-Wertheim) plus a perineorrhaphy produces good results. (Fig. 2.) If the patient is still in the childbearing age and the aforementioned operation is decided upon, the Fallopian tubes should be sectioned and the proximal end of the Fallopian tubes kept outside the peritoneal

cavity by stitching the cut edge of the peritoneum well below the uterine fundus on the posterior uterine wall. In many

bladder freed from the cervix and fixed at a higher level on the uterine wall. The cardinal ligaments are then stitched across

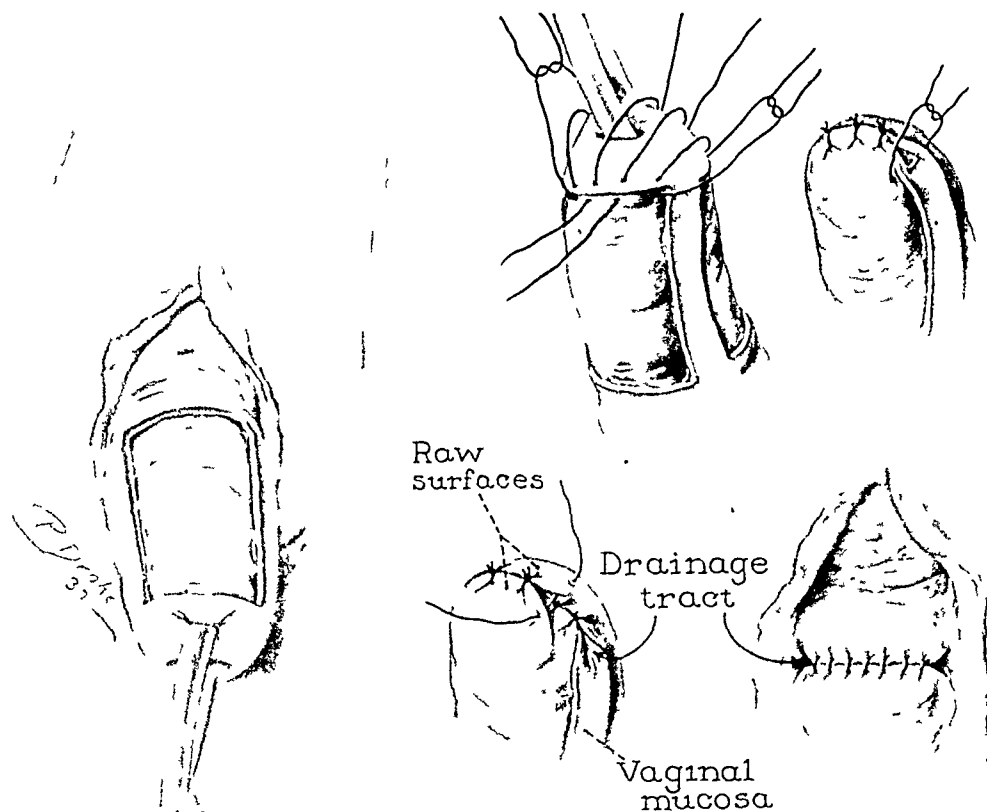


FIG. 5. Various stages of the LeFort partial vaginectomy.

cases, and especially before the menopause, the uterus is too large to permit the regular technique, but this difficulty can be overcome by cutting away a portion of it. In some cases, I have removed more than half of the organ, including all the anterior uterine wall and the interstitial part of the Fallopian tubes, all the endometrium and all the cervix. I then stitched what was left of the uterus into a pear-shaped mass, and interposed it as a living pessary under the bladder, firmly fixing it into the anterior vaginal wall with interrupted sutures.

*Manchester (Fothergill) Operation for Uterine Prolapse.* In other cases, particularly when future childbearing is contemplated, the Manchester type of operation (as described by Fothergill) can be done. (Fig. 3.) This operation usually requires that the cervix be amputated and the

the anterior surface of the uterus at about the level of the internal os, thus forcing the cervix toward the os sacrum. The musculofascial tissues in the anterior vaginal wall are then brought to the midline, and after removing the excess of mucous membrane, the cut edges of the anterior vaginal wall are also closed with enough tension to obliterate all dead space. A perineorrhaphy is essential in all cases.

*Mayo Vaginal Hysterectomy for Cystocele and Prolapse.* If the uterine prolapse is grade 3 or 4, the Mayo type of vaginal hysterectomy for correction of cystocele and uterine prolapse is satisfactory. (Fig. 4.) In performing this operation, the uterus is removed through the vagina, the cul-de-sac of Douglas is partially obliterated, and the broad ligaments of the uterus are approximated in the midline. The approximated broad ligaments are then sutured

under the bladder, functioning as a support for that structure; the broad ligaments are also sutured into the anterior vaginal wall

sutures taken from the fasciae latae will be essential to give the necessary support. Powell suggests the use of a strip of fascia

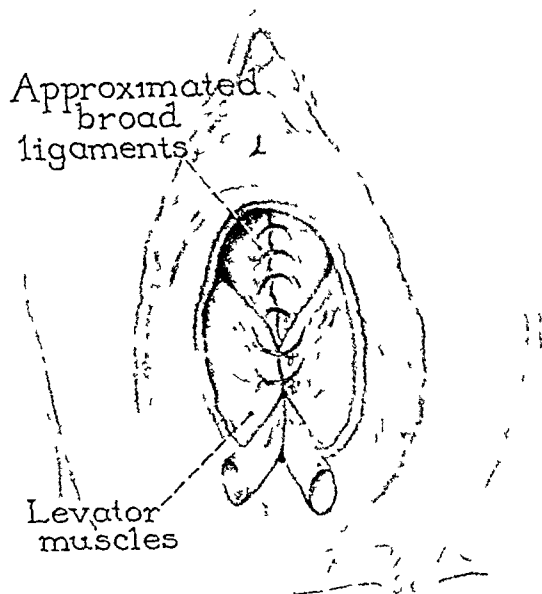


FIG. 6. Vaginal hysterectomy followed by colpectomy. The approximated levator ani muscles are stitched to the lower edge of the approximated broad ligaments.

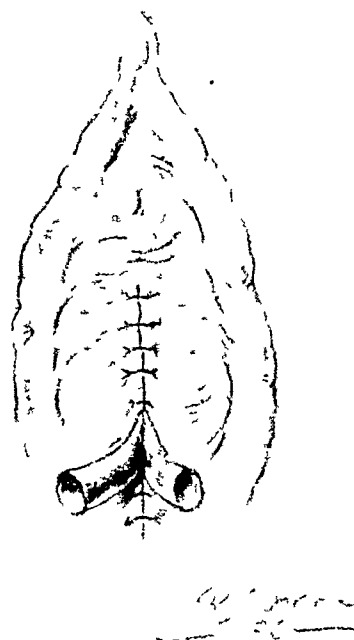


FIG. 7. Colpectomy completed by closure of the cut edges of the mucous membrane.

as the uterine body is sutured in place in an interposition operation. In cases of marked prolapse, this operation is indicated for only elderly patients, because there is usually some shortening of the vagina after the procedure has been completed.

*Partial and Complete Colpectomy.* It is not at all uncommon to encounter marked prolapse of the vault of the vagina accompanied by a cystocele and rectocele following a previous hysterectomy. These are always difficult cases to repair adequately and yet retain a satisfactory vaginal canal. If the patient is elderly, there is no objection to performing a complete colpectomy. In the case of younger women, it is advisable, after performing a plastic operation on both the anterior and posterior vaginal walls, to open the abdomen and to reconstruct, as much as possible, the normal support for the vaginal vault or the uterine cervix. In some cases, the use of living

taken from the rectus abdominalis muscle, leaving it attached at its lower end.

In some cases of marked prolapse of the uterus in elderly women, it is advisable to do the LeFort type of partial vaginectomy; but I believe that in cases in which any such operation is indicated, it is better first to perform a vaginal hysterectomy and then a complete vaginectomy. (Figs. 5, 6 and 7.) This procedure is no longer than, and is as safe as, others.

*Fixation and Shortening Operations.* In occasional cases, a plastic operation on the anterior and posterior vaginal walls, followed by a shortening of the round ligaments of the uterus or by some type of fixation of the uterine fundus in the anterior abdominal wall, are both satisfactory procedures; but no method of shortening the round ligaments or fixation of the uterine fundus in the anterior abdominal wall is in itself a cure for cystocele in the case of a patient who is required to be on her feet for long periods. It does produce marked relief and an apparent cure of the

cystocele for a short time, but sooner or later an elongated cervix and a large cystocele will appear at the vulva as the

ring in the midline through the perineal body. Both types of tears interfere with the normal closing of the vagina and the

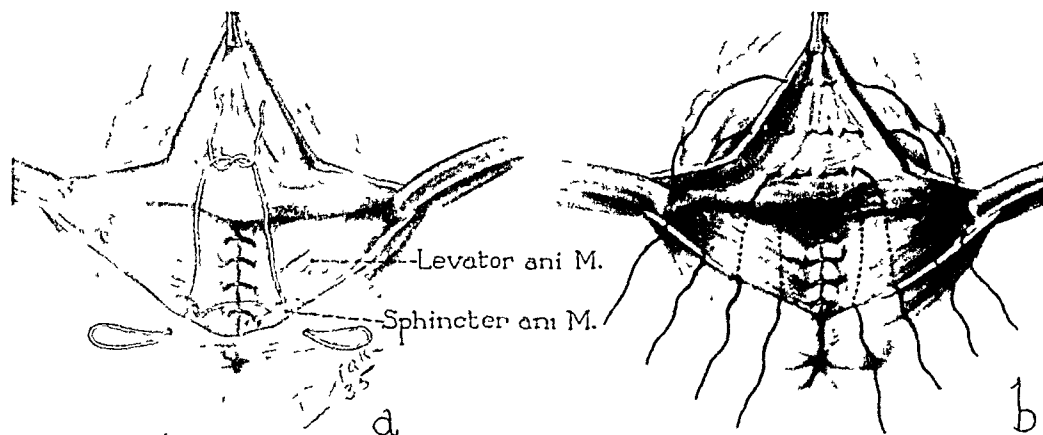


FIG. 8. a, the slip stitch used in the repair of sphincter ani muscle. b, the ordinary type of repair of lacerated perineum with approximation of the levator ani muscles in the midline and insertion of a series of crown sutures, the tying of which changes the axis of the vagina and reconstructs a perineal body.

result of stretching of the weakened anterior vaginal wall. In several cases following performance of a Kocher or Murphy type of operation, I have seen the cervix protrude through the introitus vaginae, accompanied by a large cystocele, and yet the fundus in these cases remained attached to the recti muscles.

In many cases of marked prolapse of the uterus and cystocele, there is apparently little or no rectocele because the increased intraabdominal pressure causes the cervix to impinge on the posterior vaginal wall, holding it back in much the same manner as a pessary would. In such a case, if any operation is performed that is simply designed to hold the uterus and bladder up, the patient will in a very short time notice the development of a marked bulging of the posterior vaginal wall, a bulging she had not experienced before.

#### INJURIES TO THE PERINEUM

All types of gynecologic hernias are more or less dependent upon injuries to the perineum. The injuries are of two types: (1) tears of the vaginal sulcus which involve the levator ani muscles and the deep pelvic fascia on either side of the posterior vaginal wall; and (2) those occur-

ring in the midline through the perineal body. Both types of tears interfere with the normal closing of the vagina and the

normal support which the levator ani muscles ordinarily give to the anterior vaginal wall when intraabdominal pressure is increased.

*Surgical Treatment.* Sulcus, or lateral, tears are more common in occurrence than midline perineal tears, and as a rule they can be satisfactorily repaired immediately after childbirth. If this repair is not done, and a rectocele develops, it will be necessary thoroughly to separate the protruding bowel from the vaginal wall and to anchor it at a higher level to normal tissues. The excess of vaginal mucous membrane should then be removed and a new perineal body should be constructed, using the approximated levator ani muscles as a base. By so doing, the normal axis of the vagina is restored. This operation (Fig. 8) is not an anatomic repair at the site of the laceration, but it offers good mechanical and physiologic results.

Midline tears of the perineum may involve only the perineal body with a resulting relaxation of the levator ani muscles. In such cases, primary repair, or a late repair similar to that used for vaginal sulcus tears, is satisfactory. If the tear is a little more extensive, the sphincter ani muscles will be injured and in extreme

cases the tear may extend into the anal canal. Primary repair of such tears is not satisfactory. As a rule, it is advisable to wait about five months to allow all raw surfaces to become completely epithelized and to permit the underlying tissues to develop a good blood supply and to become free from infection. The most important consideration in the surgical treatment of complete tears is to obtain a competent anal sphincter muscle by means of a plastic operation on both the anterior anal wall and the sphincter ani muscle. Following this procedure, a repair of the perineum similar to the type used in less extensive tears should be done, utilizing the levator ani muscles to hold the rectum back. Reconstruction of a new perineal body to correct the vaginal axis is essential to a good result.

#### CONCLUSIONS

1. The tendency to procidentia uteri can be overcome in most instances by satisfactory repair of lacerations at the time of childbirth or soon afterward.

2. Nonoperative measures, such as the use of tampons and pessaries, have a limited field of usefulness.

3. It is important to realize that the condition under treatment is a hernia, and that the larger the hernial opening, the more difficult will be the closure of it.

4. The type of operation to be performed should be carefully selected in each case, and the surgeon should keep in mind the extent of the prolapse, the size of the associated cystocele and rectocele, the age of the patient, her marital state, and the relative dangers of an abdominal or vaginal operation.

5. An enterocele, or true vaginal hernia, is occasionally present in association with or without other types of gynecologic hernia.

6. In difficult or recurrent cases of marked gynecologic hernia in elderly patients, it is sometimes advisable partially or completely to obliterate the vaginal canal.

7. A perineorrhaphy is an essential part of the operative repair of all gynecologic hernias.

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# UTEROTUBAL INSUFFLATION WITH SPECIAL REFERENCE TO TECHNIC

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**D**URING the past twenty years since the inception of this nonoperative test for tubal patency many modifications of the procedure have been reported. In the beginning oxygen was used. The amount of oxygen was measured roughly by counting per minute the number of bubbles that passed through a wash bottle. A Baumanometer was attached to measure the pressure produced by the gas passing into the uterus and through the fallopian tubes.

From the outset an attempt was made to control the two physical factors involved in tubal insufflation, namely, volume and pressure. These factors were considered next in importance to definite clinical indications and contraindications which had to be laid down in order to safeguard the patient against untoward sequelae and possible risk. No modification of the method which does not provide these essentials can be considered adequate.

The idea basic to the new method appeared at first so simple that many lost sight of the elements essential for safety. Thus air was soon adopted in simplified technics. The objection to the use of air became clearer as experience with it in large and small series of cases accumulated. It was soon appreciated that air had the inherent element of danger of producing embolism, while the shoulder pains due to its persistence lasted from one to several days, depending upon the quantity which was insufflated.

Simplified methods with air occasionally adopted as the medium for insufflation using rubber bulbs and syringes of varying types and capacities were resorted to during the early period of development of the test. Bearing in mind the essentials for a safe and scientific procedure, the necessity

of assembling an apparatus which combined elements of precision was met gradually.

The use of oxygen from the start was aided by a rough measuring device and a manometer. Two changes were made in this respect: First, carbon dioxide was substituted for oxygen because the former was theoretically more rapidly resorbable and less prone to produce embolism while reducing or eliminating persistent shoulder pains. The second was to employ a volumeter of fixed capacity. For this purpose the siphon meter, as employed in the chlorinating of water, was adopted. Pressure in the carbon dioxide tank was further regulated by a reducing valve to one atmosphere or a fraction which was found useful in providing a constant pressure rate flow.

The delivery of carbon dioxide in a constant rate flow was considered important. First, it produced less violent reaction on the part of the uterus and tubes; secondly, it served as a means of comparison of the reactions between patient and patient, and particularly when it was deemed advisable to repeat the test in the same patient for diagnostic or therapeutic purposes at stated intervals. A constant, uniform rate flow is unattainable by the hand when employing bulb or syringe. (Fig. 1.)

After experience with the first several hundred insufflations, it became clear that the recording of the pressure variations previously observed by watching fluctuations in the manometer might prove of interest and perhaps of value. In 1925 a kymograph was added to the insufflation apparatus employing carbon paper at first and soon thereafter an ink recorder. (Fig. 2.)

The data derived from this completed insufflation apparatus since 1925 and 1926 have proved to be increasingly valuable.

fallopian tubes were normal as in cases associating fibromyomas and they were completely absent when the tubes were

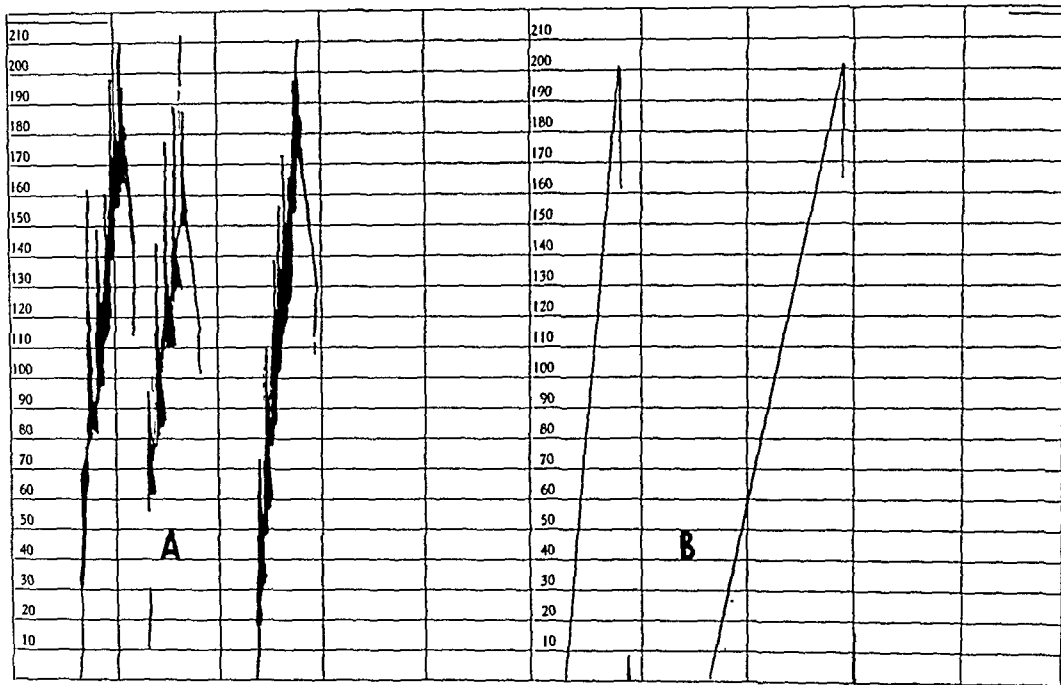


FIG. 1. Note difference in kymographic record between A, obtained by using hand pressure on rubber bulb, and B, constant rate flow obtained by reduction valve and siphon meter.

At first the graphs obtained of individual insufflations served as permanent records for the patient's gynecologic history. Later they indicated that not only was tubal patency distinguishable from nonpatency but such variations were obtained that when grouped into certain patterns, they appeared to be characteristic of permeable tubal strictures, peritubal adhesions and uterotubal spasm.

The correct interpretation of these graphs required checking by laparotomy observations, by controlled examination with radiopaque substances (hysterosalpingography) and by experimental reproduction of the pathologic conditions underlying the pattern changes. The experiments were made upon inanimate devices and upon living and dead organs. In a number of instances the extirpated uterus and tubes which were removed for various gynecologic conditions were kept in the surviving state for several hours and subjected to insufflation. Rhythmic contractions were manifested when the fal-

lopian tubes were normal as in cases associating fibromyomas and they were completely absent when the tubes were nonpatent. In the presence of adhesions and distortion of the tubes there were apt to be atypical contractions.

The dead organs exhibited no rhythmic contractions and permitted the gas to pass through the tubes under varying primary pressures without undergoing rhythmic oscillations. The oviducts of sows, of monkeys and of rabbits also subjected to experimental insufflation exhibited similar rhythmic contractions under normal circumstances or none when they were dead or nonpatent. The living intact oviducts of monkeys and rabbits manifest rhythmic pressure changes closely resembling the rhythmic contractions which are obtained in clinical tubal insufflation.

These manifestations of function of the fallopian tubes cannot be demonstrated when air is employed as in the simplified methods nor when carbon dioxide is used instead of air, without a constant uniform pressure rate flow. Though I have advised the use of carbon dioxide instead of air injected by the hand syringe in order to

avoid the persistent shoulder pains and also the possibility of air embolism, it was with the knowledge that the results would be incomplete.

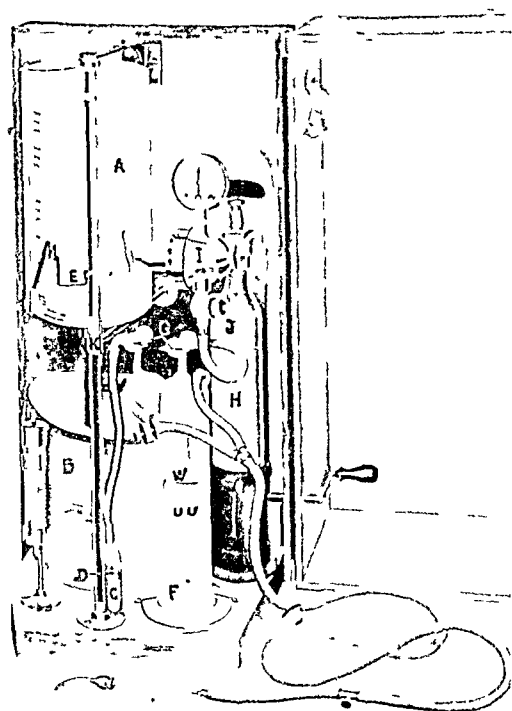


FIG. 2. Kymographic insufflation apparatus with ink recorder.

Comparative study of the graphic records during the past fifteen years has brought out data that are now considered invaluable. The method of kymographic uterotubal insufflation has in recent years been employed as a method of biodynamic assay of hormones and of pharmacodynamic assay of oxytocics and other substances used in gynecology and obstetrics. This special application obviously interests research workers but its chief sphere of usefulness is in the clinical investigation of female sterility and infertility.

Before entering into a description of the technic it is necessary to appreciate what the test is designed for and under what circumstances it is safe to apply the procedure. For these reasons the indications are the following:

Specifically, uterotubal insufflation is designed to diagnose the fact of patency or nonpatency of the uterotubal tract in

cases of sterility. Kymographic insufflation establishes the particular functional state of the fallopian tubes.

The contraindications are: (1) pelvic inflammation (acute or subacute); (2) presence of genital bleeding; (3) presence of pregnancy; (4) pelvic tenderness without other evidence of pelvic inflammation.

An indispensable precaution in each case is to make a careful, thorough bimanual examination including specular inspection of the cervix and vagina. The presence of pelvic tenderness and of profuse secretions despite their nongonococcal character should contraindicate insufflation. The latter can be deferred until these unfavorable conditions are corrected by appropriate treatment.

The aseptic procedure involves removal of simple, vaginal and cervical secretions by aspiration and sponges and of painting the external os and the vaginal portion with tincture of iodine, mercurochrome, merthiolate or metaphen. The use of suction under twenty pounds of pressure removes cervical secretions (simple water suction is also useful as is suction from a bulb syringe). The most favorable time for insufflation is a few days after a regular menstrual period.

#### TECHNIC

The patient is in the lithotomy position. The uterine cannula is gently passed up into the uterine cavity to a point just above the internal os while the acorn expansion (rubber or metal) engages the external os of the cervix. (Fig. 3.) If the uterus is retroverted, an attempt should be made to bring it forward. When we are dealing with cases of sterility, it is advisable, in any event, to restore the uterus to the anterior position. If this is not feasible, the uterine cannula should be gently passed into the uterus in the backward direction. (Fig. 4.) In either case there should be no trauma. Grasping the anterior or posterior cervical lip with a volsellum is not necessary as a rule and may be reserved for instances where a

cervical stricture impedes the introduction of the cannula. In the latter exigency a suitable smaller cannula may be employed

again and oscillating for as long as the insufflation is continued, one, two or three minutes.

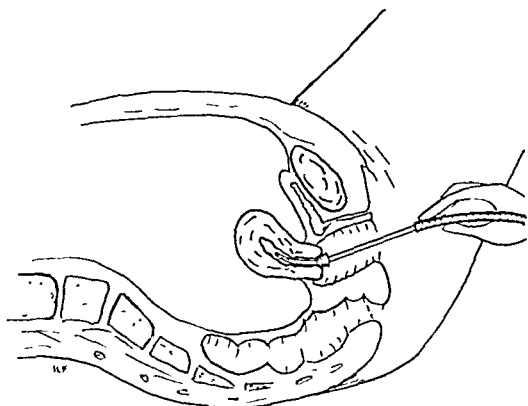


FIG. 3. The uterine cannula inserted within the uterine cavity, the acorn extension engaging the external os of the cervix. The tip of the uterine cannula is well within the uterine cavity. Uterus in normal anteverted position.

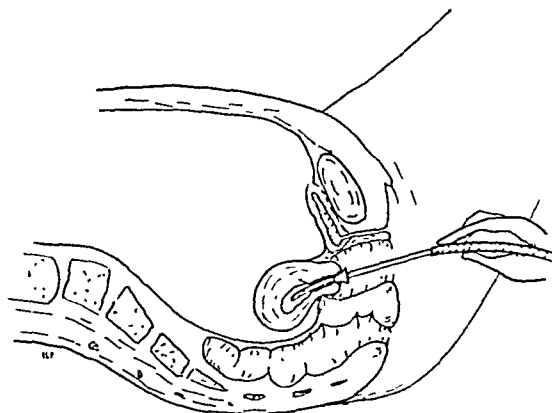


FIG. 4. The uterine cannula inserted within the uterine cavity, the acorn extension engaging the external os of the cervix. Uterus in retroverted position.

or measures instituted to dilate the cervical canal. It is always best under such circumstances to defer insufflation for a future time when it can be done without trauma.

The carbon dioxide gas under a primary pressure of fifteen pounds and regulated

If the pressure continues to rise above 100 mm. Hg, it is due to obstruction which may be caused by spasm or by organic stricture or occlusion. In case of the last condition the pressure rises to the maximum level of 200 mm. Hg at which point it is maintained for a few seconds

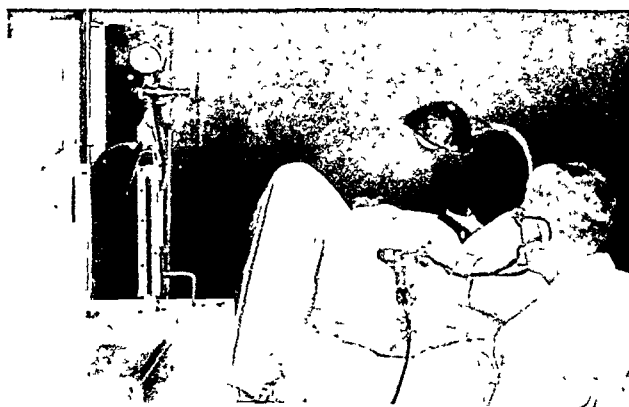


FIG. 5. Weighted stethoscope.

to flow at a rate of 60 cc. per minute is allowed to escape through the needle valve for a few seconds until the uterus accustoms itself to the cannula. (Fig. 3.) The valve is shut as the pulsation of the siphon takes place thus starting with zero pressure and zero quantity. When the tubes are patent the pressure rises at once to different levels below 100 mm. Hg as a rule and drops sharply 10:20:30 and 40 mm. Hg below its initial height, rising

after the carbon dioxide flow has been stopped. The cannula is allowed to remain in the uterine cavity during this brief interval. If the pressure drops slightly or more markedly while the cannula is held firmly in the cervix and there is no regurgitation (the gas circuit being air-tight), the decline in pressure is very likely due to a slight escape through a strictured but partially patent tube or tubes. Repeating the insufflation immediately or at another

time may demonstrate that the carbon dioxide has succeeded in traversing a minute opening in one or both tubes.

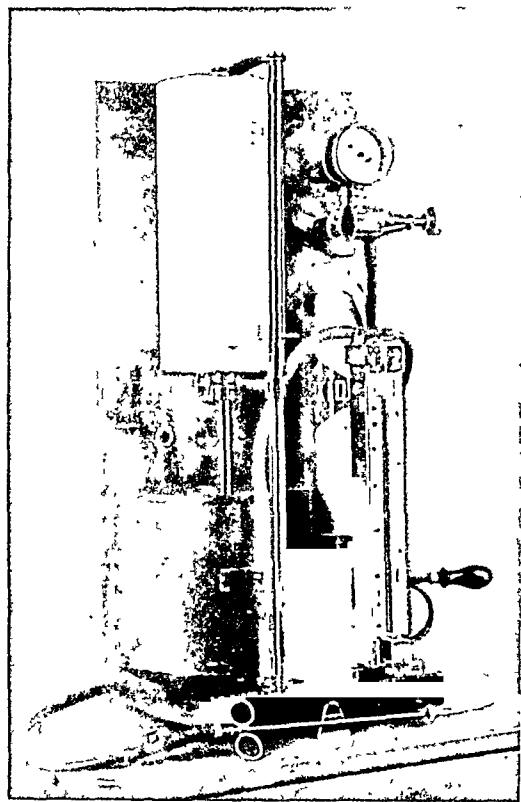


FIG. 6. Showing newer type of flow meter (Foregger type).

If after exceeding 100 mm. Hg the pressure suddenly drops to levels much lower and rises and falls in rhythmic fashion, it is evident that the uterotubal junctions were in a condition of spasm.

If the pressure rises to levels below 100 mm. Hg and is maintained at more or less the same level without exhibiting oscillations at all or feeble recording, i.e., shallow fluctuations, the tubes may be said to be held down by peritubal adhesions or dislocated by fibroids as the case may be. The relatively low pressure levels associated with shallow oscillations or their complete absence indicate that the tubal caliber is not affected but that its muscle function is impaired. A similar manifestation characterizes a depressed hormonal status, such as obtains in prolonged primary or secondary amenorrhea and the

menopause. The clinical history will differentiate between this hypohormonal state and nonconstricting peritubal adhesions.

After the graph has been obtained, which requires one to three minutes in most cases, the cannula is withdrawn. Note is taken whether gas regurgitates from the cervix and to what extent. In cases requiring higher pressures there may be prolonged cervical regurgitation after the cannula is removed, which indicates that the carbon dioxide has been retained under pressure within the uterine cavity and in one or both tubes. This does not as a rule take place to any appreciable extent when the tubes are normal.

During the insufflation, attention to the presence of pelvic pain helps to localize the site of obstruction, if any be present. In normal tubal patency there is slight discomfort during the test in the suprapubic area which disappears at once as soon as the cannula is removed. In the presence of bilateral uterotubal spasm this discomfort is increased. The same symptom is present when we are dealing with bilateral obstruction at the uterotubal junctions. If tubal obstruction is encountered beyond the uterine end, pain will be present lateral to the midline and depending upon whether it is present on one or both sides, its distribution will be unilateral or bilateral. The nearer the obstruction is located to the fimbria, the farther out will the pain in the pelvis radiate. The same reactions are met in permeable strictures.

Abdominal auscultation offers another aid in identifying open or closed tubes. Any stethoscope can be used for this purpose especially if the auscultation is left to an assistant. Without such help one can resort to any of the head stethoscopes or the conveniently weighted one devised by Leff. (Fig. 5.) The carbon dioxide passing through the fimbriated end produces a whistling, purring sound. If, for example, the right tube is open and the left tube closed, the tubal soufflé will be heard in the right lower abdominal quadrant and vice versa, if the left tube is

open and the right tube closed the bruit is heard on the left side.

Bilateral patency permits of an audible souffle in both lower abdominal quadrants. Without going into refinement of sound production and its musical interpretation, it is important to note that the tubal souffle in normal tubes is intermittent and rhythmic corresponding to physiologic contractions and relaxations. In strictured tubes with partial patency the sound produced is constant, if at all audible, and lacks rhythmic recurrence because the tubal muscle under these circumstances is pathologically altered.

At the completion of the test, the cervix is wiped clean of the slight bloody ooze that may be present and a vaginal tampon is inserted to be worn for a few hours. As soon as the speculum is removed, the patient is allowed to sit up and is instructed to take a few deep breaths. This usually gives time for the carbon dioxide to rise to the diaphragm where it produces a subphrenic pneumoperitoneum of varying depth. The presence of carbon dioxide gas below the diaphragm produces pain in one or both shoulders and occasionally in the epigastrium.

The patient may be fluoroscoped immediately when the subphrenic pneumoperitoneum becomes visualized corresponding, as a rule, to the shoulder where the pain is localized. The fluoroscopic examination is corroborative. It is not absolutely essential in normal cases because the tubograph and shoulder symptoms are pathognomonic and it can be dispensed with in cases of nonpatency. But in the presence of high grade permeable strictures or when dealing with highly nervous patients whose subjective reactions cannot be relied upon, the fluoroscope can render important diagnostic aid.

The carbon dioxide may not rise to the diaphragm if (1) the quantity insufflated is too little, i.e., under 50 cc., (2) if the tubal strictures are tight requiring high pressures to circumvent so that only the least amount of carbon dioxide passes into

the pelvis which may become absorbed while the patient is lying in the recumbent position and hence not reach the diaphragm, (3) if pelvic adhesions offer a barrier, and (4) if adhesions exist between the diaphragm and the superior surface of the liver which prevent the formation of a subphrenic pneumoperitoneum. This is not infrequent in old gonococcal infections in which the clinical history records the presence of upper abdominal and shoulder pains associated with the pelvic attack, which has resulted in the violin-string adhesions between liver and diaphragm described by A. H. Curtis.

The location of the shoulder pain is not diagnostic of the patency of the corresponding fallopian tube as carbon dioxide passing through the right patent tube may produce pain in the left shoulder while the gas escaping into the peritoneal cavity from the left patent tube may produce pain in the opposite shoulder. Both tubes may be freely patent and only a left-sided subphrenic pneumoperitoneum or a right-sided pneumoperitoneum be produced. Much depends upon the position of the colon, the distribution of the intestinal coils and upon the weight and mobility of the liver and stomach.

The pains in the right shoulder are more common than in the left shoulder because the stretching of the falciform ligament produces a more definite irritation of the right phrenic nerve. On the left side because apparently of the greater range of mobility of the stomach, pain in the left shoulder is not uniformly produced. It requires a deeper left subphrenic pneumoperitoneum to cause phrenic irritation than a right-sided subphrenic pneumoperitoneum. In making the fluoroscopic examination, the subphrenic space under the right diaphragm is always clearer and unmistakable, while that on the left side should be differentiated from the stomach gas which is practically always present. In the latter case, the simple device of placing the patient on her left side and applying pressure over the right costal areas allows

the carbon dioxide to rise to the right subphrenic space where it is easily recognized. The patient notices the change by shifting of the pain from the left shoulder altogether to the right shoulder or by a marked lessening of the pain which may persist momentarily in the left shoulder. Fluoroscopically, the complete displacement or a marked reduction of the left subphrenic pneumoperitoneum can be noted.

The fluoroscopic examination requires but a few seconds immediately following which the patient is placed upon the table in the Trendelenburg position. Gentle pressure over both costal areas helps to displace the carbon dioxide toward the pelvis where it is rapidly absorbed while the pains in the shoulder disappear at once. After five or ten minutes, depending upon the amount used in the insufflation, the patient, free of symptoms, is allowed to get up and go about. She is able to resume her ordinary duties as if she had undergone a simple cystoscopic examination.

If a repetition of the test is considered advisable, it may be done after several days or after a month, observing in each case the rules of technic including bimanual and speculum examination and aseptic precautions. The apparatus with a siphon-meter makes the possibility of repeating the insufflation under the same physical conditions.

In the last two years I have been able, thanks to Dr. Foregger, to add a quantitative device which permits not only the quick adjustment of the rate of flow, i.e., 60 cc. per minute, but also to vary this rate of flow conveniently for experimental purposes to slower rate flows. (Fig. 6.) The remainder of the kymographic insufflation apparatus, including blow-off safety device, is the same. Although intended to be foolproof, a desideratum earnestly wished for, such devices for insufflation which fix the rate flow completely to an unalterable flow rate restrict its flexible use. Unfortunately, every device, no matter how perfect, is subject to mishandling

in one form or another. In any event, some degree of latitude must of necessity be allowed the operator. The siphon meter has a device (Fig. 3) which regulates the rate flow to a constant and uniform delivery of carbon dioxide. By regulating the needle valve (Fig. 2), the operator can change the flow to any desired speed between 30 and 60 cc. per minute. In order to stop the carbon dioxide flow the glass stop cock, "G," is turned to vertical position after which the tank valve is shut. The needle valve, "J," remains open to allow the flow of gas at the rate of 60 cc. per minute. All that is necessary for a new insufflation is to open the tank valve and to turn the stop cock, "G," to the horizontal position which insures the uniform gas flow of 60 cc. per minute as prearranged. In applying this procedure as in any other diagnostic procedures, failure to take physical, i.e., mechanical precautions or of observing clinical indications and contraindications, can lead to untoward accidents and sequelae.

#### SUMMARY

In the hands of many who have used tubal insufflation, and have observed the precautions, the method has been carried out routinely with safety. In the course of the past twenty years its scope has gradually broadened. Its present usefulness may be summarized as follows:

1. To determine the status of tubal patency or nonpatency.
2. Before deciding upon the advisability of a cervical and abdominal operation to relieve sterility.
3. As a postoperative measure to test and maintain the patency of the newly formed stoma.
4. To check the results of a tubal sterilization operation with due pressure precaution.
5. To determine secondary effects upon the tubes, following induced abortions,

uterine retrodisplacements, appendicitis, tubal pregnancy and myomectomy.

6. In studying the physiology of tubes, as in functional amenorrhea, during the menopause and following x-ray castration.

7. To determine the tubal status in suitable cases before prescribing contraceptive measures.

8. To produce a pneumoperitoneum as an aid in abdominal diagnosis.

9. In the treatment of dysmenorrhea.

10. As a therapeutic substitute for laparotomy to improve the status of adherent and strictured tubes.

11. As a clinical biodynamic assay of hormonal and oxytocic effects.



SARCOMA of the breast is not a common disease. . . . It originates in the connective tissue of the organ, being deeply placed in its substance, or perhaps more frequently developing in the outer and upper quadrant.

From—"Rose & Carless Manual of Surgery," Edited by William T. Coughlin (The Williams & Wilkins Company).



# INJURIES TO THE PENIS, URETHRA, SCROTUM AND TESTICLE

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## INJURIES TO THE PENIS

**I**NJURIES to the penis are rare. They practically never occur in the flaccid organ. The injuries may be self inflicted or caused by a second party. Trauma also occurs in industrial accidents. Stutzin<sup>1</sup> and J. Steinberg<sup>2</sup> have reported interesting cases of self mutilation. Complete traumatic avulsion<sup>3-6</sup> of the skin has been met with. Other etiologic factors are: the use of firearms,<sup>7-10</sup> violent sexual intercourse,<sup>11</sup> the use of strong chemicals such as iodine,<sup>12</sup> and the hypersensitivity to epinephrine in local anesthesia,<sup>13</sup> producing gangrene.

Avulsion of the skin is treated by plastic surgery. Since no two cases are alike the ingenuity of the surgeon is taxed. Contusions are superficial and caused by trauma to the erect penis. Rupture of small subcutaneous vessels, due to the laxity of the skin, cause an extravasation of blood in the subcutaneous tissues. At times, this bleeding is marked and produces a disfiguration with edema. Following a cessation of bleeding, a purplish discoloration supervenes and at times extends to the scrotum. Treatment should proceed along conservative lines. Rest and cold compresses should be employed to check bleeding. When bleeding has been checked hot compresses are to be applied. Hematomas should be evacuated.

## RUPTURE (FRACTURE) OF THE PENIS

This implies a tear of one or more sheaths of the corpora with marked bleeding. Subcutaneous rupture of the urethra is rarely seen in the penile portion; 92 per cent occur<sup>14</sup> in the perineum. Rupture is caused by different forms of trauma; such as, direct blows, sudden collision or the dropping of a window on the organ. I shall very briefly point out the highlights of the anatomic factors involved:

The main portion of the penis consists of three elastic bodies separated from each other by envelopes of strong tissue. The corpora cavernosa occupy the dorsal position and lie side by side. In the ventral groove formed by their opposition is the corpus spongiosum through which passes the urethra. The corpora cavernosa are invested by a dense, fibro-elastic sheath or tunica vaginalis which is tough. It consists of two layers, an outer longitudinal and an inner circular layer.

The corpus spongiosum, which is composed of erectile tissue in addition to a sheath enveloping the corpora cavernosa and spongiosum, is surrounded external to these by another sheath, which binds all these structures together and is known as Buck's fascia or fascia penis. The rounded extremities of the corpora cavernosa are completely invested by this covering and extend to the angle of the penis where it joins the suspensory ligament.

When rupture occurs, sudden pain associated with a crackling sound is felt at the site of injury. The penis soon swells and reaches an immense size due to the marked extravasation of blood. The penis bends toward the uninjured side. If the bleeding spreads symmetrically to the scrotum, we have a bilateral rupture of the corpora. If deflection occurs to the injured side, one corpora is generally ruptured. Rupture may be simple or compound. For proper treatment is necessary to distinguish between the two. Bleeding from the meatus usually appears if the urethra is involved.

Treatment should include rest, elevation of the penis and cold compresses. If the effusion persists, incise, ligate and suture the sheath. Hematomas are drained. Later immobilization of the penis in a splint is instituted to prevent deformity. Prognosis

is to be guarded, as deformity of the penis is frequent and causes difficulty in sexual intercourse and psychic reactions.

#### STRANGULATIONS OF THE PENIS

Strangulation of the penis is produced by any form of constriction back of the glans. The etiologic factors are many: a tight rubber band to hold a dressing, a tight bandage following circumcision, rings and bushings.<sup>15-19</sup> Strangulation has been known to occur in children due to a stupid mother or maid, who has been known to ligate<sup>20</sup> the penis to prevent enuresis. Long hair has acted as a ligature.<sup>21</sup> The end result may be gangrene of the penis and urethra with permanent fistulas. Dislocation of the penis is exceedingly rare. It is caused by a force so mechanically applied that the penis leaves its "moorings" and becomes displaced into the scrotum, groin, perineum or abdomen. Treatment consists in reducing the dislocation and taking care of the complications.

#### INJURIES TO THE URETHRA

Injuries of the urethra are of great importance; as urinary obstruction, extravasation and fistulas occur. Urethral rupture is the commonest and most serious. External wounds of the urethra have been common during warfare<sup>22,23,24</sup> but uncommon during civil life. Intra-urethral injuries result from trauma caused by a ragged calculus, improper instrumentation, a few internal urethrotomies,<sup>25</sup> some transurethral resections, certain second-stage prostatectomies and by the introduction of foreign bodies such as pins.

Difficult instrumental deliveries during labor and the improper and wrong use of drugs<sup>26,27</sup> injected into the urethra have been a factor. External blows<sup>28</sup> and violent sexual intercourse<sup>29</sup> have also been a factor. In one of my cases, a young man during an onanistic spell introduced a needle into his urethra for a distance of six inches.

Rupture of the urethra is the commonest and most serious injury. The rupture may be longitudinal, transverse, complete or

incomplete, extrapelvic or intrapelvic. No part of the urethra is immune. Rupture of the pendulous portion is the least affected and may be caused by a fall, external blows or violent sexual intercourse. Straddle falls invariably produce injury to the bulbous or bulbomembranous portion of the urethra. These injuries are the most serious. Rupture of the posterior urethra seldom occurs without a fracture of the pelvis.

*Sex Incidence.* Approximately 90 per cent occur in the male because of occupational activity. The male urethra is firmly fixed with its close relation to the pubic bone. In the female the urethra moves with the anterior vaginal wall, and is less firmly attached.

Since the extravasation of the urine and blood is completely controlled by the two layers of the triangular ligament and Colles's fascia, it is essential to review briefly the extravasation possibilities controlled by these structures, for these aid us in a correct diagnosis. The union of Colles's fascia with the deep layer of the triangular ligament forms a space termed the superficial or anterior perineal. This is only opened anteriorly where it communicates with the superficial and deep layers of the abdominal fascia. This space contains the bulb, spongy portion of urethra and distal end of the membranous urethra. Extravasation at these points cannot go upward because of the dense inferior layer of the triangular ligament nor can it go backward into the ischiorectal region, inasmuch as the deep layer of Colles's fascia fuses with the inferior layer of the triangular ligament. The extravasation cannot spread into the thighs for both Colles's fascia and inferior triangular ligament attach laterally to the pubo-ischi rami. Thus a rupture of the urethra at the bulb, spongy portion, or distal end of the urethra causes a tumefaction at the scrotum, perineum, penis and lower abdominal wall.

If the membranous urethra is involved, the extravasation occurs in the ischiorectal fossae, buttocks or thighs. Tears of the superior triangular ligament cause extrav-

asation in the space of Retzius. The extravasation is held forward by Denonvillier's fascia. The peritoneum is pushed up from the bladder with extravasation passing to the space of Retzius.

*Diagnosis.* A pendulous urethra, slight hemorrhage, pain and difficulty in urination are diagnostic. Infection and urinary extravasation may occur. With a pendulous urethra that has been ruptured intense pain following injury, tumefaction resulting from hemorrhage, urinary infiltration, marked hemorrhage, hematoma in perineum and extravasation of urine may all be present. Difficulty in urination begins at once. An edema of the posterior urethra follows and causes acute retention. Urinary extravasation generally does not begin at once because of spasm at bladder sphincter. This spasm is approximately overcome at the end of twenty-four hours by the over-distended bladder. In a membranous and prostatic urethra bleeding may be absent from the external meatus. Urinary extravasation is deep seated in the perivesical tissues and between prostate and rectum.

*Treatment.* The first thing to do is to treat the shock, and to divert the stream of urine. There is a difference of opinion regarding the treatment of intrapelvic or bulbous urethra. Bailey<sup>30</sup> cites twelve methods that have been used in locating the severed end of the urethra but all are time consuming. On the other hand Rutherford,<sup>31</sup> in 1904, stated, "that in the lithotomy position the severed urethral ends are a considerable distance apart, yet when the legs are extended the severed ends are in approximation."

The urethral membrane has great powers of regeneration in urethral injuries by virtue of rapid proliferation of its epithelium. This explains how a complete rupture, which has nothing more than a cystotomy, has had excellent functional results even though no attempt has been made to unite the severed ends. This point has been advocated by Foulds.<sup>32</sup>

First, attempt to divert the stream of urine with a soft rubber catheter and leave

the catheter in place for a week. Do not try the passage of a catheter in ruptures of the posterior urethra or those complicated by a fracture of the pelvis, as this would be adding "insult" to injury. In these cases an immediate cystotomy is the method of choice.

Urethrotomy may be attempted, which is performed in three ways: (1) End-to-end anastomosis;<sup>33</sup> (2), a retention catheter with neither urethral or perineal closure;<sup>34</sup> (3) a resection of all bruised parts, mobilization of the proximal spongy portion sufficiently to permit a free end-to-end anastomosis of healthy portions of the urethra over a large catheter.

The following case on our service illustrates how proper judgment produces good results:

A boy, 14 years of age, fell from a roof on to a gate with spikes. He fell with legs adducted. Examination revealed a swollen scrotum, non-transparent to light and the perineum swollen and red.

At operation a complete rupture of the urethra was found at the bulb which was separated for two inches. A rubber catheter No. 14 was passed through the distal urethra and then treaded through the proximal urethra. The edges of the urethra were sutured with three No. 1 interrupted chromic sutures.

The patient was discharged after eighteen days with the wound completely healed and 100 per cent of urine passing through the urethra. The after treatment of all tears of the urethra is of the utmost importance.

*Prognosis.* The mortality is slight except those complicated with fracture of the pelvis, laceration of bladder and internal injuries.

#### INJURIES TO THE SCROTUM

The scrotum may be subjected to extensive injury without damage to the testicles, because the latter slips away. Bleeding at times is profuse and ligation is necessary. The skin of the scrotum has a tendency to inversion, hence it must be ligated carefully. Due to the laxity, elasticity and redundancy, injuries favor extreme edema,

distention, extravasation and discoloration. The scrotum has great power of regeneration following denudation.

Besides being submitted to external injuries, damage to the scrotum is met with in industrial accidents causing avulsion<sup>35,36</sup> of the skin. Injuries have been caused by the self injection of foreign bodies, such as paraffin,<sup>37</sup> and the sensitivity to epinephrine<sup>38</sup> in local anesthesia. Gangrene of the scrotum<sup>39</sup> following closed operation for hydrocele has been reported. Avulsion of the skin of the scrotum is treated by plastic surgery.

#### INJURIES TO THE TESTICLE

The testicle is usually traumatized by a direct blow, because of its mobility and position in the scrotum. Slight trauma is painful and produces various degrees of shock due to the pressure or irritation of the testicular nerves communicating by way of the spermatic plexus with the aortic and solar plexus. Various degrees of pathologic changes are noticed ranging from capillary hemorrhages to rupture of the tunica albuginea with a hemacele.

In many of these injuries atrophy ensues due to cicatrices. Atrophy is also produced following herniotomy as a result of the interference of the blood supply of the spermatic cord and following recurrent torsion of the cord. The Romans produced eunuchs by squeezing the testicles of infants between their fingers. This trauma induced atrophy. A repetition of the injury will cause malignancy.<sup>40</sup>

Treatment should consist of rest, elevation of scrotum, cold compresses at first and later hot compresses. If infection supervenes with pus formation, evacuation should be employed. If hemorrhage is severe, operative interference is necessary. Stab wounds heal readily if no infection is present. If the tunica albuginea has been cut, it should be sutured to prevent hernia of the testis.

Industrial lesions are rare. In a series of 100 cases Crane<sup>41</sup> found only three that were really attributed to an industrial

accident. Injuries to the epididymis and testis are always associated. Orchitis is rare because of the firm support of the tunica albuginea. Close investment also accounts for the slower swelling. Epididymitis alone, except in the rare hemotogenous infections, is always secondary to infection of the prostate and seminal vesicles. To exclude malingering, a complete genito-urinary examination is necessary. The prostate and vesicles should always be examined. Epididymo-orchitis may be produced by a strain, i.e., pulling, lifting and straddling. This is probably caused by a violent contraction of the cremasteric muscle striking the pillars of the external abdominal ring.

Dislocation of the testicle is exceedingly rare and mostly congenital. There are three types: (1) internal, inguinal, abdominal or femoral; (2) external, subcutaneous inguinal, pubic, penile, perineal and crural. (3) rupture through the scrotum.

Treatment involves the replacement of the testicle manually; if unsuccessful, surgical intervention is necessary.

Torsion of the testicle is a twist of the spermatic cord, either to the right or to the left and may occur at any age. The etiologic factor is some congenital anomaly. The exciting cause is a muscular exertion as jumping or heavy lifting which causes a sudden contraction of the cremasteric muscle. Occasionally, the testicle is found to be the site of malignancy. The symptoms are the same as for epididymitis or orchiepididymitis.

*Diagnosis.* There is usually a sudden onset, severe pain, high position of the testicle, local swelling and tenderness. Pain ceases following gangrene.

*Treatment.* An attempt should be made to rotate in the direction opposite to the pain. If unsuccessful, immediate surgical intervention is necessary. The testicle should be anchored to prevent recurrence.

#### CONCLUSION

Injuries of the penis, urethra, scrotum and testicle have been briefly considered. The causes are varied and some are un-

usual. The urologist must be on the alert, as no two cases are alike. At times his ingenuity will be taxed and after treatment is of the utmost importance.

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# UNDESCENDED TESTICLE

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THE management of cryptorchidism in one's office of necessity confines itself to proper examination, diagnosis and classification of each individual case, plus the intelligent application of hormonal therapy.

The treatment of this interesting condition by gonadotropic agents is generally recognized notwithstanding the fact that reports are so varied that the average practitioner is somewhat confused and, at times, disappointed in their use. Many still question the value of organotherapy on the basis that a certain good percentage of ectopic testes will descend spontaneously of their own accord. Obviously, whether or not this occurs will depend upon the underlying etiologic factors, namely, mechanical obstruction to descent or dysfunction of the endocrine apparatus. The incidence of undescended testes is less after puberty than before that period, suggesting strongly that the hormonal changes incident to puberty produces spontaneous descent in a good percentage of cases. In the following paragraphs, it is proposed to discuss the nonsurgical treatment of this malformation.

It is beyond the scope of this paper to touch on the many underlying theoretic problems involved here, particularly the physiology of descent, still a controversial question, the pathologic anatomy or hormonal deficiencies. However, the fact is that in the human species it is normal for the testes to descend into the scrotum before or soon after birth and to remain there continuously. Successful descent provides the essential environment so necessary for spermatogenesis and the proper, full growth of the orchids. Retained testes beyond puberty are invariably sterile because the spermatogenic epithelium is damaged. Of great importance, too, is the tendency of the undescended testes to undergo atrophy

and, in a certain definite percentage of cases, malignant degeneration may occur. Recent work has shown that there may be a deficiency in the endocrine function of the malpositioned organ. In addition to all this, and not the least important, is the psychic effect of the condition on the growing child. One then appreciates the importance of cryptorchidism and the need for our efforts to correct it properly.

Malposition of the testes is encountered in two types of boys: First, there are those who, aside from maldescent of one or both gonads, are normal. The second group includes boys who have signs of hypothyroidism or hypogonadism as well as cryptorchidism. It is a fact that in the child with cryptorchidism and hypogonadism, hormonal therapy is most effective. The clinical studies of Shapiro and Sexton, Spence and Scowen, etc., tend to bear out this statement. Especially is this true if the testicle is retractile, that is, not fixed in its abnormal position.

Treatment for undescended testes may be postponed until the boy is 10 or 11 years of age for the following reasons: First, as already stated, the testes may descend spontaneously before this time provided there is no barrier present. Second, there is no clinical or experimental evidence to prove that harm results to the gonads by reason of its retained position prior to natural puberty. Whether watchful waiting for spontaneous descent, surgical intervention or hormonal therapy is advisable, will depend largely upon the fixation of the testicle. Spence and Scowen have stated very definitely that, "the disadvantage of waiting for spontaneous descent in any except the retractile type is that if an anatomical abnormality is present, spontaneous descent can never occur. Waiting until after puberty in the hopes of spon-

taneous descent is in such cases an unnecessary and unjustifiable delay." Orchidopexy, in this instance, is clearly indicated before puberty has set in. Rea positively states that in his experience, spontaneous descent of a testis retained by mechanical factors never occurs, and he doubts the value of the use of hormonal therapy in these cases.

All patients when first seen should be subjected to a thorough physical examination, noting first the general appearance of the child, second, the degree of development of the genitals and third, the situation and mobility of the testes. Of importance, too, is the patient's age. After consideration of all the above factors, the following rules may be laid down: (1) In a preadolescent cryptorchid child, otherwise normal and in whom the testicle is retractile, it is good judgment to wait until he is 10 to 11 years of age before therapy is considered. If spontaneous descent has not occurred, hormonal therapy should be instituted for at least three months. If no positive results follow or if evidence of the onset of premature puberty should become manifest, operative intervention should be advised without delay. (2) If, in the same type of patient, the testicle is fixed in its malposition, one can conclude that an anatomic barrier to descent is present. Orchidopexy, in this instance, should be considered before puberty and preceded by hormonal therapy for one to two months. In this situation, organotherapy is indicated because of its growth promotional effects induced in the cord structures. We refer to the influence on the elongation and development of the spermatic cord and the pampiniform plexus. These effects are necessary precursors of successful plastic surgery. (3) If the patient has already attained puberty and whether the testicle is fixed or not, surgery should be advised without delay, preceded by endocrine therapy to facilitate the procedure. (4) Where evidence of other glandular deficiencies exist, supplemental treatment should be instituted for its correction.

The routine plan of hormonal adminis-

tration that we consider adequate yet safe is to give 300 rat units of any of the reliable brands of gonadotropic agents twice a week for eight to ten weeks. If no positive response is noted after four to six weeks' rest, a second similar course of treatment is given. Treatment is discontinued when no effect is noted. It is generally considered that this amount of treatment is adequate to bring about a favorable result and that if descent has not occurred, it can reasonably be assumed, in most cases, that an anatomic barrier exists. Orchidopexy is advised without too much delay, because having induced in the testes tissue changes characteristic of puberty by administering hormones, degenerative changes and loss of spermatogenic function will surely occur if the gonads remain extrascrotal.

Male sex hormones (testosterone propionate) may be used to advantage in those cryptorchids with hypogenitalism. In our experience its growth promoting effect on the penis and testicles is, at times, quite definite. The plan usually followed is to administer two to three injections a week, 5 to 10 mg. each, for a period of four to six weeks. A total of 60 to 80 mg. constitute a course. After a rest interval of four to six weeks, a second course may be given.

Caution should be exercised against the employment of excessive quantities of endocrines. It has been shown recently by investigators, principally Eisenstaedt, Appel, Fraenkel and Rolnick, Lieberthal and Baker, that large doses are distinctly detrimental. At operation, these workers found that in patients who received 6000 rat units or more of hormone, the testicle had a peculiar mottled appearance and was reduced in consistency and size. If 4000 or less rat units were given, the testicle appeared not unlike those of patients who received no therapy at all. In one instance reported by Eisenstaedt et al., the testis had been reduced to a pea-sized organ. These are very distinct degenerative changes and these facts have necessitated revision of our previous conceptions concerning the efficacy of massive doses of hormones.

It might be mentioned, in passing, that a few writers have suggested the use of endocrines as an adjunct to surgery post-operatively and claimed an improvement in their operative results.

#### CONCLUSIONS

1. Careful study of every cryptorchid is essential before therapy is advised and administered.

2. There is sufficient evidence that endocrine therapy alone will produce descent of

the ectopic testis when there is no anatomic barrier.

3. Surgery should be advised in cases in which the testicle is fixed in its abnormal position.

4. Endocrine therapy is of distinct help in distinguishing between those ectopic testes that require surgical intervention because of anatomic factors and those that do not.

5. Hormonal therapy, in proper dosage, is a valuable adjunct to surgery, pre-operatively and postoperatively.



THERE is little to suggest that primary tuberculosis of the epididymis ever occurs. It is secondary to some other focus in the body. Its association with other urogenital foci is more common, though it does, at times, occur as the only lesion of this tract.

From—"Office Urology" by P. S. Pelouze (W. B. Saunders Company).



# LESIONS OF THE MALE BREAST\*

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LESIONS of the male breast are infrequent in the larger medical clinics and very unusual in the average office practice. Therefore, it suffices if the general physician or surgeon has ordinary knowledge concerning the diagnostic possibilities and the accepted forms of therapy. As a rule no aggressive therapy is necessary except in malignant disease which is easily recognized.

The usual textbook states very little concerning the male breast, and the literature, though bounteous, confuses one as to the relative occurrence of various lesions. In this presentation, abnormal processes are subdivided into four groups not because of their scientific accuracy but for simplicity.

## CONGENITAL ANOMALIES

Supernumerary nipples constitute the most frequent anomaly, occurring more often in the male than in the female. Landauer<sup>1</sup> records an incidence of 1.94 per cent in men and 1.20 per cent in women. Usually considered as a mole by the patient, these redundant nipples are easily recognized by their appearance and situation along the primitive milk lines of the embryo. No treatment is necessary but local excision with procaine infiltration suffices where cosmetic or esthetic reasons indicate removal.

Hemihypertrophy of the male breast is very uncommon, occurring more frequently on the right than left (Landauer). It can be differentiated from unilateral mastitis by the history of constancy. If therapy is indicated, simple excision of breast tissue with preservation of the nipple as reported by Christopher<sup>2</sup> suffices.

Hemiatrophy cannot truly be said to occur in the male breast and requires no consideration.

## TRAUMA

Unlike the female breast, the male breast is uncommonly affected by trauma. Although very vascular, the absence of loose cellular tissue minimizes the chances of hematoma as observed in women. Fat necrosis as described by Lee and Adair<sup>3</sup> in the breast of the obese woman could presumably occur in the male but has not been reported. Ordinary abrasions, contusions and lacerations require therapy similar to those of the skin and subcutaneous tissues elsewhere.

## MASTITIS

The term, "mastitis," is almost as evasive in the male as in the female breast. Here it will be used to denote the apparently inflammatory processes strictly non-neoplastic. Andrews<sup>4</sup> in an excellent review of the subject selects the term, "swellings," rather than suffer ambiguity with more scientific terminology. He reported seventeen cases, none of which represented new growth with the possible exception of one case whose material histologically bore some resemblance to adenofibroma. Wood-yatt<sup>5</sup> had previously suggested the possible development of adenofibromas from chronic mastitis.

The etiology of mastitis is somewhat problematic. Andrews<sup>4</sup> feels secure in attributing the process to external sepsis due either to poor local hygiene or the presence of surgical infection elsewhere with secondary invasion of the mammary tissue from without. He discusses the observations of Cooper<sup>6</sup> and presents studies

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of his own to show that the male breast is not the very rudimentary organ usually depicted by our texts, but a relatively complex series of ducts and alveoli which should be susceptible to infection. Andrews furthermore believes that gynecomastia represents no more than the usual irritation or infection accompanied by unusual fibrous tissue response. As reasonable and acceptable as the infectious theory appears, one must also attend the possibility of hormonal causation. Wernicke<sup>7</sup> presents a good review from this angle and the evidence suggests a relationship between gynecomastia and the glands of internal secretion, particularly the testicle. Sir Astley Cooper mentions a swelling of the breast in a man with atrophy of one testicle. Of Wernicke's four cases, three had atrophy of the left testicle. However, there was also local trauma to the breast in all four of these patients. Cheate and Cutler<sup>12</sup> would divide gynecomastia into two clinical types: those associated with abnormal sexual function, sometimes testicular defects, and those in which sexual organs and function are normal. Until further evidence accrues, it appears more conservative to disregard the hormonal relationship, particularly as regards therapy.

Mastitis, including gynecomastia, need not be further subdivided for clinical purposes. It is by all odds the most common lesion of the male breast. Of forty-one lesions observed or treated by Horsley,<sup>8</sup> twenty-three were mastitis of some type. The diagnosis is relatively simple, occurring at any age, characterized by rather rapid appearance of a moderately tender, indurated, button-like mass beneath the nipple. Nipple secretion is rare and fever or leucocytosis is seldom observed. The disease usually endures several months and gradually subsides.

Treatment should be very conservative. It seems unwise to advise surgical excision in a process of this type, but at times excision may be indicated by the chronicity of the inflammatory tissue. The use of endocrine products can be tried if one is

optimistic about their usage. Wernicke<sup>7</sup> and Wolf<sup>9</sup> have administered anterior pituitary-like substance. Wernicke also gave these patients testosterone propionate, which produced some testicular enlargement and a beneficial effect on the breast in two of four cases. In a disease somewhat self limited, one must draw conclusions with care. The usual local heat as applied to low-grade inflammation elsewhere can be used to advantage. The use of external roentgen radiation would appear reasonable in a process of this type but there is a paucity of reports of such therapy. Wolf<sup>9</sup> suggests such treatment but apparently has had no experience. Kaplan<sup>10</sup> advised 150 r twice weekly for four to five weeks but makes no statement as to results. One patient has been treated in the Cleveland City Hospital Tumor Clinic and obviously no conclusions can be drawn.

The granulomatous infections such as tuberculosis and syphilis are too rare to merit attention in a brief review. One interesting paraffinoma, developing two years after paraffin injection, was treated by surgical excision and reported by de Cholnoky.<sup>11</sup>

#### NEOPLASM

If one restricts the use of the word tumor to connote neoplasm, tumors of the male breast are uncommon and the most common tumor is cancer. The literature tends to be confused as regards ratio of benign to malignant tumors, because of the loose usage of tumor to denote swelling. Billroth (quoted by Andrews) said that benign male breast swellings were rare. Andrews, on the other hand, had not seen a malignant tumor in his practice. Cheate and Cutler<sup>12</sup> present a composite table in which 87.5 per cent of neoplastic lesions were malignant and 12.5 per cent benign. This ratio probably approximates the correct one for neoplastic disease.

Benign lesions are so infrequent that the average clinician is unlikely to see one. Even the lesion called adenofibroma may, as stated above, represent only mastitis.

Simple excision with procaine infiltration suffices for benign neoplasm.

Cancer of the breast is easily recognized in the male, occurring rarely before the age of 55. It becomes adherent to skin very early, ulcerates early and is attended by considerable pain. Adherence to pectoral fascia and axillary node invasion are common. The decision as to operability may be a difficult one, but in the absence of radiologically demonstrable metastases to lungs or bone, radical mastectomy under general anesthesia should be performed. No attempt should be made to effect skin closure because of the early invasion of skin and the necessity for wide removal. On the basis of our present knowledge, postoperative roentgen irradiation should be given if the axillary nodes show carcinoma histologically. The advanced carcinoma with marked skin and fascia invasion or with inoperable axillary nodes should be treated by irradiation alone.

#### CONCLUSION

Mastitis is the most common swelling of the male breast and should be treated conservatively until chronicity impels operation.

True neoplasms of the male breast are uncommon. Cancer is the most common of these neoplasms and is easily recognized.

Minor surgical procedures on the male breast are very infrequent in the usual office practice.

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# THE SYMPTOMATIC TREATMENT OF ACUTE EPIDIDYMITIS\*

## A PRELIMINARY REPORT

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ACUTE epididymitis is one of the most painful and incapacitating ailments but has little mortal significance. Since our facilities were not adequate for the hospital treatment of this condition, acute epididymitis was a troublesome problem for the urologic staff. The usual forms of therapy, including such medication as intravenous calcium chloride or gluconate, plus scrotal support, usually afforded the patient little relief, especially when he had considerable distance to travel to his home and bed. It was evident that more effective symptomatic treatment was needed.

Block of the vas deferens with 1 per cent aqueous procaine hydrochloride, as suggested by Imbert,<sup>1</sup> gave but temporary comfort. It was decided to prepare this agent in an oil base to prolong the anesthetic action. We failed in every attempt to produce a clear solution of procaine hydrochloride. We then prepared an oil solution of nupercaine base as suggested by Gabriel.<sup>2</sup> However, this preparation caused a moderate temporary swelling at the site of injection, probably due to phenol.

### ANESTHETIC AGENT

The present formula for our anesthetic solution is:

Nupercaine (base)	5
Benzy alcohol	10
Olive oil	qs ad 100

The benzyl alcohol serves as a solvent for the nupercaine (base) and is in itself

a mild anesthetic agent. Nupercaine (base) is used since the acid salt precipitates out of solution. Olive oil was substituted for almond oil for economic reasons.

### TECHNIC OF INJECTION

The patient is placed in the supine position and the vas isolated between the thumb and forefinger of the left hand as far as possible from the testicle. With the vas held firmly the overlying skin is cleansed with alcohol and anesthetized with an aqueous local anesthetic. A No. 22 caliber needle attached to the syringe containing the oil base anesthetic is introduced into the sheath of the vas. It is practically impossible to pierce the substance of the vas, since its loose sheath affords adequate protection. After the operator has made certain that the needle point is not within one of the vessels of the pampiniform plexus, 0.5 to 1.0 cc. of the anesthetic is injected and the needle withdrawn. It will be noticed that the epididymis is insensitive to ordinary pressure within 30 to 60 seconds after gentle massage over the injected site.

Often the tail and head of the epididymis will remain slightly tender to strong pressure, but the patient can now stand or jump about without the slightest discomfort. A scrotal support is applied and the primary disease treated as usual since we have produced but symptomatic relief without changing the pathologic picture.

The exact duration of the anesthesia is difficult to determine, but is at least four

\* From the Urological Service of Owsley Grant, M.D., University of Louisville School of Medicine and the Louisville City Hospital.

to eight days. However, in none of our cases did the anesthesia disappear before the patient's condition had progressed to a painless state, and there has been no recurrence of epididymal pain after the patient has been initially relieved.

#### CASE REPORTS

In twenty cases of patients with acute epididymitis treated with nupercaine (base) in oil, all obtained complete and almost instantaneous comfort without any untoward effect. No demonstrable change in the disease was observed, except for questionable shortening of its course. A large series of cases will be needed to substantiate this point.

On four occasions we have injected the anesthetic solution into cords, which were markedly inflamed and indurated, with no deleterious effects. In each case pain was instantly alleviated and there was no

further enlargement of the cord nor any evidence of spread of infection. The histologic change in the subcutaneous tissue and the subsequent patency of the vas is to be reported at a later date together with additional cases.

#### SUMMARY

1. Nupercaine (base) in oil injected into the sheath of the vas promptly stops pain of acute epididymitis.
2. The usual treatment for the primary cause of acute epididymitis is necessary since the injection therapy is but a symptomatic measure.

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# THE TREATMENT OF ANAL FISTULA IN OFFICE PRACTICE\*

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IT might be emphasized at the outset that the treatment of fistula of the anal region in office practice should be the rare exception rather than the general rule.

Most fistulas with an external opening at or near the anal outlet ordinarily are not as simple or uncomplicated as they may seem. Studies of fistulas and sinuses of the anal region by stereoscopic radiographs, after the injection of an opaque solution through the external openings, have demonstrated the serious nature of these conditions.

Fistulas usually originate from perianal or perirectal abscesses which either rupture or are opened by the surgeon. These abscesses in turn usually follow infection of the anal crypts, perianal hemorrhages or trauma. A perianal hemorrhage is usually due to a ruptured hemorrhoidal vein and the resultant hematoma is called a thrombotic hemorrhoid. If its covering is mucosal, it is an internal thrombotic hemorrhoid; while a subcutaneous hematoma is known as an external thrombotic hemorrhoid. If an internal thrombotic hemorrhoid becomes infected and opens internally and externally, a fistula will result. If it opens only internally, it becomes an internal sinus.

Trauma of internal origin affecting a crypt is often followed by abscess formation and ruptures externally producing an anal fistula. Perforating or punctured wounds often produce fistulas.

Any abscess which drains externally usually degenerates into an external anal sinus. These sinuses were formerly called internal or external blind fistulas, respectively.

Multiple complicated and grave fistulas such as those which communicate with pelvic, abdominal or contiguous organs as the vagina, bladder and urethra, must always be considered in dealing with the subject of fistula. However, the treatment of these can be accomplished successfully only in the hospital.

Anal fistulas are so designated because they are located in the anal region, therefore, fistulas whose internal openings are located in the rectum are also beyond the scope of this article.

Most fistulas and sinuses can be diagnosed not only by stereoscopic radiographs as already mentioned, but many can be outlined by injections of colored solutions or pastes through an external or internal opening. The emergence of the colored material through other external or internal openings provides excellent guideposts to their locations. While it is relatively common to see a number of external openings, more than one internal opening is rarely encountered.

The only types of fistulas for which minor surgery can be accomplished under regional anesthesia in office practice are those which after a complete study have been found to be of the simple, uncomplicated variety. Those which either perforate or undermine the external sphincter muscle should not be considered for any type of office treatment. Simple, direct, subcutaneous fistulas can be operated upon in office practice as can small external perianal sinuses.

Internal submucous sinuses can, in selected cases, be opened and drained without hospitalization. A number of simple,

\* From the Department of Proctology, Wayne University.

direct, anal fistulas originating in infected crypts, whose tract runs just underneath the anal lining to the skin, are also amenable to office surgery.

No treatment of a surgical nature should be attempted in office practice unless one has a rest room available where a patient can be allowed to recline for a period after the office surgery has been completed. No matter how small a quantity of any local anesthetic drug is administered, some patients will exhibit a marked reaction or depression following its administration. Allowing the patient to rest from thirty minutes to an hour or two after an office fistulectomy is good insurance against any weakness, reaction or hemorrhage.

Some external perianal sinuses will respond to the injection of bismuth paste and will heal without surgery. This treatment could be tried before surgical drainage is instituted. Bismuth paste consists of one part of bismuth subnitrate and two parts of vaseline. This is thoroughly mixed and sterilized in a hot water bath. A glass sinus syringe with a long curved shank and conical tip is employed for the injection of the paste. The bismuth paste is heated to fluidity. With the patient lying on either side, the conical tip is pressed against the opening of the sinus and the paste injected with gentle pressure until resistance is encountered. If there is more than one sinus, each should be treated likewise. A dressing is then applied and the patient asked to return every three or four days until the sinus ceases to drain.

The majority of external perianal sinuses will not respond to the injection of bismuth paste. These will not heal properly until adequate drainage is provided. X-ray studies of these sinuses usually show them to be bottle-necked.

In order to have the sinuses drain properly an incision must be made so that the skin wound is as wide as the widest part of the sinus cavity. It is well to trim back the skin edges so that the incision becomes either an oval or circular opening. Rubber tissue or cellophane is lightly packed into

this cavity and is removed in twenty-four to forty-eight hours. It is not necessary or desirable to repack the sinuses as they will heal much more rapidly if allowed to collapse naturally.

The anesthesia necessary for these simple sinuses is the same as that administered for office fistulectomy. Care must be exercised to prevent puncture of the cavity and the injection of the anesthetic solution into it. In order to avoid this the anesthetic injection must be started at least a half inch away from the cavity walls. Then the gloved finger is inserted into the anal canal with the palmar surface directed towards the sinus. This will serve as a guide to the hypodermic needle and prevent puncture of the anal canal during the injection of the anesthetic solution.

Bismuth paste is injected in the same manner for the diagnosis of fistulous tracts. If instead of a sinus a simple direct fistula is present, its direction, extent and the location of the internal opening are disclosed by the emergence of the yellow bismuth paste in sharp contrast to the pink mucosa. We prefer the use of the paste to a colored solution because the paste remains in situ and can be palpated as well as seen. Colored solutions, on the other hand, escape and stain the surrounding surfaces. The paste, moreover, is an excellent lubricant for the passage of a soft flexible wire probe which we use, not only as a diagnostic instrument but as a tractor when the ends are twisted together.

After the surrounding surfaces are infiltrated with a  $\frac{1}{2}$  to 1 per cent metycaine solution, particularly all tissues beneath the fistula, the tractor is of material assistance in the fistulectomy. Parallel incisions are made on either side of the wire converging outside of the external and just beyond the internal openings. With gentle traction on the tractor these incisions meet in a V-shaped manner below the fistula and it is excised threaded on the probe.

Ligatures are not necessary unless arterial bleeding is encountered. Usually the

coagulating current or cautery will control the bleeding. A strip of rubber tissue or cellophane is placed in the wound as a drain, then a gauze compression bandage and a pad supported by adhesive strips are applied. The drain is removed in twenty-four to forty-eight hours and as a rule, not replaced. These simple fistulas heal in a very few days and the patient is not compelled to abstain from his usual duties.

The whole subject of surgery of the fistula is one of the most important in the whole field of proctology. The successful treatment of a complicated and often times a simple direct fistula will tax the ingenuity of the most skillful specialist. For that reason, a note of extreme conservatism will be seen throughout this short article. It must be remembered that the demand for office treatment of not only fistulas but other anorectal conditions as well emanates from those who wish to avoid hospitalization.

General anesthesia was another matter to which many patients objected because of unreasoning fear or prejudice. With the almost universal employment of nonsleeping types of anesthesia by proctologists in the majority of anorectal operations, this objection is no longer valid. Of course,

certain unethical practitioners who are denied hospital privileges, stress office treatment and office surgery, and play upon the prejudices of the bewildered patient against hospitalization for anorectal diseases.

The employment of regional, caudal and low spinal anesthetics has robbed anorectal surgery of many of the imaginary terrors which existed only in the minds of the uninformed. These types of anesthesia have rendered the operation not only easier, because of better relaxation of the parts, but also have actually shortened the period of hospitalization to such a marked extent that prospective patients are no longer so apprehensive.

While the limitations of proctologic surgery in office practice are governed to a large extent by the ability, skill and equipment of the individual surgeon, a warning note should be uttered lest the uninitiated be led astray by overenthusiasm.

I would conclude by advising that every patient suffering from a fistula or sinus be given the benefit of hospitalization even for a short period, rather than be forced to undergo an operation, which in office surroundings may be incomplete and sometimes disastrous.





# ANAL FISSURE: ITS OFFICE TREATMENT\*

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OF all the affections of the anorectal region, the one that causes the most pain and suffering in proportion to its size is a fissure. Fissure as its name implies, is a traumatic condition: a split, tear or laceration of a crypt or the wall of the anus or anal canal. This may be caused by any sudden exertion or strain such as sneezing, coughing, laughing, vomiting, purging or lifting. All may be responsible for the sudden traumatization of the anal transitional lining.

The passage of unusually large, hard or irritating liquid stools also may produce a laceration of this membrane. Other causes may be the expulsion of either large or small foreign bodies which either split the lining membrane of the anal canal, or if small enough, enter and sometimes tear the anal crypts. Anal papilli may also be torn and this laceration produces the symptoms of fissure.

If the fissure persists either because of neglect on the part of the patient to seek relief, or because of inadequate or improper treatment, ulceration and induration take place. The condition is then no longer a fissure but an ulcer. Anal ulcer is what was formerly and erroneously called "chronic fissure."

The chief symptoms of anal fissure are pain, sudden in character, bleeding, which is sometimes very slight, and sphincter spasm. On account of the pain produced by a bowel movement the patient postpones future evacuations as long as possible. When defecation is imperative, the fissure tends to split further and the symptoms unfortunately increase in severity. If, on the other hand, in order to avoid constipated stools, hypercatharsis is produced by the overanxious patient, the

fissure symptoms are further aggravated by the frequent, copious, irritating, liquid fecal discharges.

While fissures occur in an otherwise normal anal canal as a result of trauma, as has been stated, this injury is more apt to happen in an individual who already has some pathologic condition such as hemorrhoids, cryptitis, papillitis or ulcerative or other inflammatory conditions of this area. Many times the patient and sometimes the physician is apt to make a snap diagnosis of "hemorrhoids" because of the presence of anal pain, bleeding and the swelling produced by the formation of a "sentinel pile." This latter condition is not a true hemorrhoid, of course, but a swollen, edematous and infiltrated crescentic fold of skin which forms at the outer angle of the fissure. While this acts as a buffer, it usually prevents good healing, and its removal is necessary to the successful treatment of fissure.

The diagnosis of fissure is easily made. A history of strain, trauma, constipation or diarrhea followed by acute spasmodic pain, which recurs with each bowel movement, should at once suggest the presence of a fissure. While some fissures do bleed noticeably, a stain on the clothing or toilet paper or a blood streak on the stool may be the only evidence of hemorrhage.

Usually the presence of a sentinel pile will indicate the location of the fissure. Before making a digital or instrumental examination the insertion or application of an anesthetic ointment is recommended. One containing 1 per cent of diothane, eucupin, metycaine, novacaine, anesthesin or other surface anesthetic is of great assistance in making an otherwise uncomfortable examination one which is

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surprisingly easy for the patient to tolerate. In some cases this may not suffice, particularly if the patient is exhausted, nervous or irritated from continued suffering.

The sphincter and surrounding tissues should be anesthetized by infiltration. After sterilizing the surrounding skin, 2 or 3 cc. of one of the anesthetic solutions preferred by the surgeon should be injected about 1 to 2 cm. behind the posterior commissure, and the injection carried up on either side of the anus in a V-shaped manner until at least half of its circumference has been anesthetized.

If, however, the fissure is located anteriorly, the injection must be carried all the way around the anal orifice. The injection should also be carried well underneath the base of the fissure. This can be easily accomplished after the initial anesthetization of the external sphincter. Digital and anoscopic examination can be accomplished after waiting two to three minutes and frequently the therapeutic measures indicated can be applied without further anesthesia.

Sometimes the fissure can be felt by digital examination, particularly if the edges have become indurated. It is our practice in making a digital examination to employ the little finger before the index finger. By doing this, most of the unpleasant part of a digital examination in a patient with a fissure is eliminated. Through a small anoscope the fissure looks as one would expect it to appear, namely, a crack through the transitional membrane which lines the anal canal and sometimes into the perianal skin. It is the extension into the perianal skin which usually produces the sentinel pile. If a larger sized instrument is used, the fissure, particularly after a local anesthetic has been injected, will appear more as an oval or rounded abrasion rather than a crack. This is due to the infiltration and the stretching of the lesion.

In office practice, two lines of procedure present themselves, one the nonoperative, and the other the surgical method. Both

are based on the principle of temporarily putting the affected portion of the external sphincter out of commission. This provides physiologic rest and allows the affected part to heal in a short time.

Before instituting treatment of any kind, the patient should be informed that a nonsurgical procedure is often merely a palliative measure and postpones surgical treatment until a later date. In many of the cases, however, injection of a lasting anesthetic will be all that is necessary. This type of treatment should be reserved for those individuals who refuse even a minor surgical procedure or who are unable to be absent from their duties for even a day or two.

*Technic.* The patient is placed in either the right or left lateral position. The skin is then prepared according to the technic preferred by the surgeon. We use alcohol and one of the mercuric tinctures. The injection is carried on as described previously. When skin and sphincteric anesthesia is completed, 1 to 3 cc. of either a watery or oily solution is slowly injected underneath the entire fissure and to either side. The needle is guided by a finger inserted into the anal canal. This also prevents the accidental puncture of the anal lining. If a watery solution is used, 1 per cent diothane or eucupin, 2 per cent quinine urea hydrochloride or 2 per cent nupercaine solutions are all employed for this purpose. If an oil soluble anesthetic is used, a 5 per cent solution of eucupin ordiothane in a vegetable oil is chosen. It should be heated to about 100°F. and a needle of a caliber not smaller than 20-gauge used. After sufficient solution has been injected under the entire fissure including the sentinel pile when present, the solution particularly if oil is distributed through the tissues by finger massage. If an oil solution is injected, a single injection is sometimes sufficient to put that portion of the sphincteric circumference at rest long enough to provide enough physiologic rest for complete healing. The patient is

instructed to take a sufficient quantity of an intestinal lubricant to guard against constipation or impacted stools. Cathartics are interdicted because liquid stools irritate the fissure.

If complete relief is not obtained injections may be repeated at intervals of four to seven days. The watery solutions as a rule do not produce as long a period of anesthesia as the oil. As long as anesthesia is produced, it is our usual practice to excise the sentinel pile and to incise the entire fissure bed. Overhanging edges may occasionally require trimming and the only vessels which need to be ligated are spurting arteries. Venous oozing is quickly controlled if quinine urea postoperative anesthesia is used, or oozing may be stopped by the application of the electrocautery. In most of the cases the application of a firm gauze dressing is all that is required.

It is important when incising a fissure that the sphincter fibers be exposed and

at least the presenting fibers be served. The outer edge of the external sphincter muscle should be incised more deeply than the internal so as to provide better drainage. A strip of rubber tissue or cellophane should be placed in the wound for twenty-four hours unless gauze pressure is desired. The patient is allowed to rest for fifteen to twenty minutes when, provided the wound is dry, he can be dismissed to return the following day for dressing. It is surprising what a large percentage of simple fissures will respond to the injection or incision treatment in office practice.

When the fissure is complicated by the presence of other rectal disease or has become a chronic indurated anal ulcer, hospitalization which is usually of very short duration should be advised.

The limitations of office methods in the treatment of patients suffering from anal fissure is measured only by the skill and the experience of the proctologist or the surgeon in charge of the case.



# OFFICE TREATMENT OF HEMORRHOIDS\*

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VERY few people have any desire to enter a hospital for an operation. No one wants to lose time from his work or business and there is a universal urge to avoid pain or suffering. The public puts constant pressure on the physician to avoid hospitalization and surgery.

Unscrupulous practitioners have publicized the office treatment of hemorrhoids as a semimiraculous method which involves no pain or time loss and eliminates the inconvenience and economic hardship of hospitalization. In the guise of treatment, rather than operation, a general anesthetic may be given and with inadequate assistance and with only the ordinary equipment of an office, an attempt is made to relieve the patient. It is difficult enough to do good work in a well equipped operating room with plenty of assistance; but to operate in an office—call it a treatment—and to allow the patient to attempt to go home afterwards is little short of folly.

The ethical proctologist knows the so-called short cuts, the office or ambulant methods, their possibilities and their limitations. He knows that there are certain definite types of hemorrhoids which are suitable for office treatment. He knows also that if most patients with complicated hemorrhoids realized the time to be consumed and the prolonged period of inconvenience involved in office treatment, they certainly would choose to have the whole thing done at once in a well equipped operating room under local anesthesia.

Hemorrhoids are essentially varicose veins in the region of the anus. The tendency to have varicose veins, including hemorrhoids, is familial. Certain members of a family may escape; others, who are subjected to long hours of standing, lifting,

or strenuous labor, develop hemorrhoids. Straining such as with constipation, diarrhea or childbirth tends to cause bleeding, protrusion and pain. School teachers, policemen, motormen, clerks and others whose occupations cause them to stand still for long periods are likely to have hemorrhoids. Intra-abdominal conditions which disturb the return flow of venous blood are a definite factor in some cases.

Hemorrhoids first appear within the anal canal above the external sphincter. As they become more prominent with the straining at defecation, they protrude through the anal opening. With each protrusion the anus is dilated, thus paving the way for more extensive protrusion. This may happen not only with every bowel movement but with every act of stooping or lifting. The patient may have to replace his hemorrhoids many times daily.

At intervals these veins may begin to bleed with bowel movements or any unusual strain. As time goes on the bleeding may occur with every stool. The surface of the hemorrhoids may become inflamed and ulcerated so that it is impossible to have a bowel movement without bruising the thinly covered veins. In constipation repeated bruising by hard stools open a path for infection.

Small foci of infection heal with the formation of fibrous tissue. This tends to contract the anus, producing more constipation and more difficult passage of stool with greater damage. Thus a vicious cycle of more damage exists and more spasm is established.

After the passage of an excessively large stool or with straining of diarrhea or childbirth, or, after prolonged standing or following a drinking bout, one of the external

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veins may suddenly rupture. The extravasated blood in the perianal tissue clots and forms a thrombotic hemorrhoid.

Less frequently a similar rupture of internal hemorrhoidal veins occurs. Large internal hemorrhoids may prolapse and the sphincter may contract and constrict them so they can not be immediately replaced. A huge and painful thrombus develops. The entire perianal ring becomes swollen, edematous and fragile. With sufficient disturbance of the circulation, large areas may become ulcerated and gangrenous, and the area may lose all semblance to a normal anus.

Thus there are many types of hemorrhoids and degrees of severity. We may have internal bleeding or protruding, interno-external bleeding and protruding, thrombosed external veins, thrombosed internal veins and complications such as infection, muscle spasm, scarring, infected crypts, polyps, fissures, abscess or fistula. Only certain types of hemorrhoids are suitable for office or ambulant treatment. Selection of suitable cases for this type of treatment is all important.

Simple internal hemorrhoids which may be bleeding or protruding are successfully treated in every proctologic office. This is best accomplished by the injection method but the same result can be attained by the galvanic current, although with much more time and trouble.

An injection of a mild escharotic solution into the upper end of the hemorrhoid produces a sterile inflammation. In the subsequent pouring out of serum, fibrin and fibroblasts, the varicose veins are squeezed and constricted by scar; the mucosa is tacked to its underlying structures and instead of a large bleeding or protruding mass of veins we finally have a flat, slightly indurated area on the wall of the rectum. There are usually three hemorrhoids: left lateral, right anterior and right posterior. If all three are injected at one time, the venous circulation can be disturbed sufficiently to develop an immense ring of external edema.

It is best to inject only one hemorrhoid, or two at the most, at one time. Five to seven days later another hemorrhoid may be injected. Occasionally there are small collateral veins which can be given a smaller injection. After the three main hemorrhoidal masses are injected, it is best to wait for three to four weeks until the induration has resolved before repeating the injection. Most proctologists agree that 5 per cent quinine and urea hydrochloride in 1 per cent novocain is the best solution to use. Five per cent phenol in Wesson or almond oil is probably the next choice. Many different but similar preparations have been used.

Two to 3 cc. of 5 per cent quinine and urea hydrochloride is placed in a 5 cc. syringe and a straight twenty-two gauge three inch needle fitted to it. The patient can be treated in the knee-shoulder or left Sims' position. A gloved finger well anointed with a water soluble lubricant is inserted into the anal canal.

A short beveled anoscope is passed with the obturator which is opened toward the known location of the hemorrhoid to be injected. If the patient is asked to bear down slightly, the veins will fill up and the most favorable location for injection can be chosen. The solution should be injected into the middle and toward the upper pole of the mass. An injection near the distal pole of the hemorrhoid may produce severe pain and sphincter spasm.

Under a good light the spot for injection is sterilized with one of the various mercurial antiseptics by means of a cotton applicator. One to 2 cc. of the solution is injected depending on the size of the hemorrhoid. There may be a slight sensation of burning but usually no actual discomfort.

The patient can get up immediately and go about his usual occupation. He is advised to use local heat in the form of a hot sitz-bath or hot compress that evening if he has any bearing down, discomfort or pain. He is advised to replace these masses immediately should they prolapse at his home and is warned that failure to do so

may result in strangulation. The injection is made through a mucous membrane surface that is constantly bathed with germs, therefore, every precaution should be taken so that the solution, equipment and site of injection be properly sterilized.

For the few patients sensitive to quinine, phenol and oil can be injected but it is necessary to have the solution slightly warmed and to use a needle of larger bore. If the patient is examined on the next day, an indurated mass can be felt, much larger in size than the original hemorrhoid. Subsequently, this mass becomes less indurated and smaller. If the hemorrhoid which bleeds the most or protrudes the worst is first injected, bleeding or protrusion may be stopped at once with a single treatment. It is no wonder then that the patient believes he has been cured miraculously. At the time he would be willing to write a most glowing testimonial. If the patient will return for further injections, the veins can be so completely sclerosed that a cure is finally effected.

Many thrombotic hemorrhoids are amenable to office or home treatment. Thromboses after childbirth frequently causes more discomfort than the childbirth itself, and surgery is contraindicated at that time. Hot glycerine compresses covered with oiled silk and a hot water bag do much to relax the spasm and reestablish proper circulation. Rest in bed allows the veins to empty easily, and applications of any soothing ointment is comforting. By the time the patient is able to be up and about most of the thrombi have been absorbed.

The ordinary external thrombosis can be treated palliatively as above, or more rapidly by injecting a local anesthetic and removing the clot. Simple incision and liberation of the clot are frequently followed by a recurrent clot. It is better to remove a radial wedge-shaped piece of tissue including the clot, and, if necessary, ligate any small spurting vessels. A gauze, pressure dressing is applied and the patient is advised to have his dressings changed

frequently. Mineral oil daily by mouth lubricates the anus and hot sitz-baths will relieve any postoperative discomfort.

In many instances thromboses are a useful warning. Many patients would never have a rectal examination if they did not have a painful thrombus. Its presence calls for a careful and complete rectal examination. To dismiss such patients with a sample box of suppositories is gross carelessness. Neglecting to examine the rectum may result in missing an early carcinoma.

Interno-external hemorrhoids can sometimes be injected. Caution should be exercised in treating this type in the office. It is true that the internal hemorrhoids can frequently be treated satisfactorily by injection, but what happens to the external hemorrhoids? Since they can not be injected, they must be removed surgically. It is possible to remove them one at a time in the office but that is like cutting off the dog's tail by inches.

Although a patient may not have simple internal bleeding or protruding hemorrhoids, there are times when injection treatment for at least temporary relief should be used. A tuberculous patient with active chest lesions should not be subjected to hemorrhoidectomy. There is a real danger of opening up the area to the tubercle bacilli swallowed. Aged patients may be carried along with injections. It is not a cure but does give the patient some symptomatic relief. The patient with severe secondary anemia may be slow in healing after surgery. Preliminary injections can be used to stop the bleeding temporarily so that the patient can be built up and hemorrhoidectomy performed safely later on.

Patients whose only complaints are bleeding or protrusion too often fail to consult their physicians. Some patients will replace their protruded hemorrhoids daily through a long life. How many times do we see patients who have bled at intervals over a period of years, some to the point where they have severe secondary anemia.

Pain is the symptom which drives most hemorrhoidal patients to the physician. Pain is evidence of a complication, which may be infection, fissure, sphincter spasm, edema, polyps or abscess as well as hemorrhoids. This is the type of hemorrhoids most often seen in the physician's office. To attempt office treatment of complicated hemorrhoids is foolhardiness. If the sphincter is relaxed at one sitting, polyps or papillae removed at another, internal hemorrhoids injected at other visits, and fistulae incised a part at a time, the patient can scarcely be thought successful in his effort to avoid pain. Injection of hemorrhoids in an infected rectum with a tight sphincter invites abscess formation and intensifies spasm and pain. Most attempts at ambulatory treatment of this type rapidly bring the patient to the point of

begging to enter the "dreaded" hospital where he knows he will get relief.

Office treatment of hemorrhoids unfortunately has been offered to the public as a miraculous means of avoiding surgery and hospital confinement. The injection treatment is a measure of great value if care is exercised in the choice of patients. If used on patients with internal hemorrhoids, which bleed or protrude, it is ideal since both complaints can be relieved promptly and painlessly. The slight loss of time and the economic saving will appeal to many. It can also be of great help, at least for temporary relief, in the aged, anemic, tuberculous and pregnant. To attempt its use in the treatment of hemorrhoids complicated by other pathology frequently spells disaster. Office treatment is not a cure-all, and, there are definite limitations to its use.



# ANAL CRYPTITIS AND PAPILLITIS\*

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THE term, "anal cryptitis and papillitis," denotes the condition produced by inflammation of the anal crypts and papillae, characterized by symptoms and changes described later. Because of frequent and varied distressing symptoms occurring in the anal canal caused by these conditions, it may be well to review briefly the anatomy of these important structures. The closed anal canal is thrown into folds, columns and depressions to compensate for the dilatation necessary for the passage of formed feces. These columns are known as the columns of Morgagni. Between the adjacent columns and placed transversely are the semilunar valves, which form the lumen boundary of minute pockets known as, "anal valves, rectal pockets, mucous crypts or crypts of Morgagni." The mouths of the crypts open upward and against the fecal current, which predisposes them to the likelihood of forming catch basins for particles from the fecal contents of the rectum. The number of crypts vary, usually from four to twelve, and when not inflamed are hardly noticeable.

At the edge of each semilunar valve a toothlike or teat-like projection is found called the *anal papillae*. They are composed of a framework of connective tissue, blood vessels and nerves, covered with squamous epithelium and contain some erectile tissue. The papillae and crypts are situated at the junction of the anal canal with the lower end of the rectum and form an irregular serrated line known as the *linea dentata*. Normal papillae are small and may be almost indiscernible, but with inflammatory change may become hypertrophied. Because of these changes, the definite clinical entities, cryptitis and

papillitis, occur more frequently than is generally believed.

The etiology of cryptitis is usually that of some foreign body lodging in the anal crypt. The more common among these are particles of bran, small seeds, fragments of bone, egg shells, tooth brush bristles, pieces of tooth picks, feces or bacteria. Because of the shape of the crypts, retained material is not readily expelled and decomposition results with ensuing injury to the mucosa and infection. This, in turn, produces a hypertrophy and increase in the depth of the crypt from a few millimeters to a deep sinus with resulting irritating discharges.

If the mouth of the crypt remains intact, the secretions are expelled into the anal canal producing irritative symptoms. Should the mouths of the crypts become sealed, the complications of cryptitis such as, pruritus, fissure, abscess and fistula-in-ano are likely to result.

Practically speaking, the infected crypt is the primary etiological factor in all anal abscesses with the exception of those due to trauma. If the infection in the crypt makes its way through or around the anal sphincter, a perianal abscess is formed; but if the crypt breaks down and drains into the anal canal, a fissure-in-ano results.

However, it should be constantly borne in mind, and is more often overlooked, that anal crypts afford one of the most fertile foci of infection of any area in the body. Cultures from inflamed anal crypts will reveal that many varieties of pathogenic bacteria are harbored there, especially many strains of the streptococcus. Due to the unusual anatomy of the anal crypts,

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retention and absorption of toxic material into the lymphatics and blood stream is definitely favored.

**Symptoms.** The symptoms of anal cryptitis may be loosely classified as local, occurring in the anal canal and perianal region, and remote or reflex to other organs. The local symptoms may vary from simple excoriation, burning, itching of the perianal skin caused by discharge from the crypts, to a pricking, uncomfortable, dull aching sensation in the less acute cases; while in the acute cases there is sharp, piercing, burning pain exaggerated by defecation, lasting from a few minutes to several hours with usually a marked spasticity of the sphincter ani muscle. Constipation often results because of the patient's fear of the pain that is produced by defecation. The more remote or reflex symptoms usually encountered are those that simulate dysmenorrhea, dysuria, prostatitis, low back pain, lower abdominal pain and tenesmus. These symptoms ordinarily subside as the inflammation of the crypts becomes less acute.

The symptoms of papillitis are described as tickling, picking, crawling (as if worms were crawling in the anal canal), and often after defecation the sensation of an incomplete evacuation and desire to return immediately to stool. This sensation is due to the hypertrophied papillae being engaged in the grasp of the anal sphincter. Pain is not a prominent symptom in papillitis and occurs, as a rule, only when a papilla has been dragged down and its base torn, producing the painful symptoms of fissure-in-ano.

**Diagnosis.** Diagnosis of cryptitis is frequently missed because of improper examination. Any of the above symptoms will lead one to suspect this condition, but actual visualization of the inflamed crypt proves the diagnosis. The examination should proceed as follows: A relaxed finger covered with a rubber cot well lubricated is gently inserted into the anus as the patient strains down (this is important, as it relaxes the sphincter which is usually

very sensitive and spastic). Crypts are not palpable though the tender points may be located by gently rotating the finger in the anal canal. The principal reason for the digital examination as the primary procedure is that if a foreign body is present, further damage is obviated by gentle palpation. Next, a well lubricated, cylindrical anoscope is gently inserted into the anal canal, in the same manner as that of the finger, and with good illumination, each quadrant is systematically searched for inflamed crypts. A hypertrophied crypt is plainly visible; but to determine the size and depth, the crypt should be explored with a hook-shaped, small, malleable, silver wire probe with an olive tip, which is inserted behind the semilunar valve and the pocket explored without danger of injuring the fragile mucosal lining. If the mucosa is injured, complications will result. With the careful execution of the above, the crypt will often be found to extend to the anal skin margin. This knowledge serves as a valuable aid in treatment.

The diagnosis of papillitis is accomplished by the same manner of examination as for cryptitis. However, hypertrophied papillae are often palpable as small, firm, fibrous projections, but here again visualization through the anoscope is the most accurate method of diagnosis. The papillae are seen as tooth-like or teat-like projections extending into the lumen of the scope and vary in length from one-fourth to more than one inch in length. Hypertrophied papillae are easily differentiated from anal polyps, in that the papillae always have a wider base than tip and the tip is pointed; while a polyp has a bulb-shaped tip, which is usually wider than its pedicle and base. Papillae are, as a rule, more numerous than anal polyps.

#### TREATMENT

The treatment of cryptitis may be surgical or medical. The common consideration given both, however, is a diet that is bland, excluding the use of harsh

laxatives, condiments and alcohol. Mineral oil should be administered each night to insure soft nonirritating stools until the acute symptoms subside.

Medical treatment consists of the local application of such agents as ichthyol, argyrol, mercurial tinctures or the careful cauterization with phenol or silver nitrate triweekly or oftener. The painful symptoms may be allayed by the use of anesthetic suppositories, ointments and the application of heat. These methods tend toward the amelioration of symptoms but are in reality only palliative, since acute exacerbations often occur.

Surgical treatment offers the most effective method of treating cryptitis and papillitis as well as disposing of the foci of infection. In surgical treatment of the anal canal as an office procedure a guarded prognosis should be given, as the slow, resistant healing of anal fissure is often encountered. All surgical procedures are necessarily effected through the limited space of an anoscope and without complete anesthesia and relaxation of the anal sphincter; thus, simple incisions of the mucosa may result in troublesome or dangerous hemorrhage.

Then the inflamed crypt has been identified, the mucosa is distended within 1 per cent novocaine, followed by the injection of a few minims of  $\frac{1}{2}$  per cent quinine urea or diathane solution. The latter are

chosen for their prolonged anesthetic properties. With scalpel or cryptotome, the crypt is incised in its full extent, parallel to the longitudinal axis of the bowel. The incision should extend well out on the perianal skin, paralleling the radial skin folds, thus preventing cupping of the wound and insuring prolonged drainage. If the mucosal edges are redundant or if there is a papilla present, they are removed by excision of the edges of the wound with scissors. Initial hemorrhage is controlled by the pressure of a cotton-tipped applicator and the base of the wound is cauterized with phenol or 10 per cent silver nitrate.

The excision of hypertrophied anal papillae is essentially the same as that described above except that the bases of the papillae are crushed with a small hemostat, which is left in place for a few minutes, and the papillae are removed by incision through the compressed line of tissue with scissors. The line of incision should extend well out on the skin margin as above.

The after-care of these wounds is most important. If the edges are allowed to bridge across or granulate too freely, healing is delayed. This is prevented by digital massage and inspection with the anoscope at regular intervals. Excess granulation is prevented by cauterization with 10 or 25 per cent silver nitrate carefully applied.



# PILONIDAL SINUS\*

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THE term, "pilonidal sinus," refers to a vestigial remnant frequently found in the skin and subcutaneous tissues of the sacrococcygeal region. At the most typical period of its development the sinus or cyst contains hair, whence its name, "hair nest." It is subject to degeneration and infection, giving rise to a characteristic clinical picture.

## ETIOLOGY

There has been much speculation as to the origin of these sinuses. Many hypotheses have been offered to explain their occurrence. Some authors believe that the condition is the result of an infolding of skin with inclusion of pilogenetic cells. Others consider them as remains of the primitive neurenteric canal. Recent work, particularly by Fox,<sup>1</sup> has suggested a striking analogy to a gland which is located in birds, certain of the reptiles and other lower forms which is known as the preen gland. This gland is situated in the sacrococcygeal region and secretes an oil with which the bird strokes its plumage. The secretion not only lubricates the feathers but is thought to play a role in sexual attraction. Whichever theory is ultimately accepted as to origin, the constant location, the characteristic pathologic picture, the relationship to adolescence and its familial tendency should be satisfactorily explained.

Pilonidal sinuses are found mostly in persons of the pituitary type, tall and obese, with broad hips and hairy bodies. However, the sinuses may also occur in persons not of this habitus. At the present time Dr. Robert C. Moehlig and the writer are investigating the role which the pituitary gland may play in the sinus

development. The results will be reported later.

In the white race the condition predominates in males over females in the ratio of about three to one. It has been stated that the condition is rare among negroes. However, among the many colored patients attending the Detroit Receiving Hospital, pilonidal sinus has not infrequently been observed. Here may be noted a paradox that among negroes the ratio of occurrence in males rather than females is reversed; colored women have the condition much more commonly than the men. The negress with pilonidal sinus tends to be fat and broad-hipped.

There is a definite familial tendency. It is not uncommon for several brothers, sisters or other relatives to have pilonidal sinuses. It is interesting to note further that in these families there tends to be an unusually large number of twins. In 1936, I reported a group of forty cases<sup>2</sup> in which more than the normal percentage of twins were found among the relatives of those having a pilonidal sinus. Mechling<sup>3</sup> and Goldberg and Bloomenthal<sup>4</sup> have noted its occurrence in identical twins.

As previously reported<sup>2</sup> the onset of symptoms occurred between the ages of 15 and 20 in 40 per cent of the patients, and between the ages of 20 and 25 in 45 per cent. This seems to indicate a relationship with the body changes of adolescence.

Fitting the clinical facts with an explanation of the pathogenesis of this condition, it might be assumed that at birth an embryonic remnant of a vestigial secondary sex gland may be present, which is constantly located in the sacrococcygeal region. This apparently plays a greater role

\* From the Department of Proctology, Wayne University.

in the male than it does in the female. The embryonic rest, while present during infancy and early childhood, remains

be wiped with alcohol to remove any oily secretions. In the mid-line there can be seen from one to five tiny, pin-point open-



FIG. 1. Characteristic section of a pilonidal sinus. Note the presence of numerous hair follicles and the beginning of fibrosis.



FIG. 2. Later stage. Hair has disappeared. Degeneration is almost complete and supuration is present.

quiescent. Then adolescence occurs and under the stimulus of the pituitary and other hormones that induce secondary sex characteristics, the hair on the body, etc., this gland, too, is activated; and, as it becomes activated, hair develops. The process continues during early puberty until late adolescence when the hair and the rest of the cyst tends to undergo degeneration. At this stage, pain, swelling and discharge occurs and the patient consults a physician.

#### SYMPTOMS

The patient usually presents himself by reason of pain or discharge. Sometimes there is a story of possible injury. Careful history taking may bring out the tendency to discomfort in this area for a considerable time. Often the patients will tell of previous abscesses that have been opened or have spontaneously ruptured. Routine examination may disclose the presence of a pilonidal sinus without any symptoms.

#### DIAGNOSIS

Diagnosis is simple. The sacrococcygeal area is carefully inspected. The skin may

ings running vertically in an almost straight line. The presence of these cribriform openings absolutely clinches the diagnosis of pilonidal sinus whether or not symptoms have ever been present.

When degeneration and infection have set in there may be seen or felt a deep, rounded swelling usually to one side or another, or scars may be present marking the site of former drainages. Openings of sinuses and fistulas may honeycomb the skin over the sacrococcygeal region extending upward for many inches or outward into the buttocks.

These tracts tend to run upward and do not communicate with the rectum. The infection generally spreads in the cutaneous tissues; the tough aponeurosis over the sacrum limits its course. Cases have been reported of osteomyelitis of the sacrum developing as a complication. While this is possible, its occurrence must be most uncommon.

#### TREATMENT

Treatment is essentially surgical. In the presence of acute abscess formation it is well to drain the abscess and allow the

acute inflammatory process to subside before undertaking radical removal. This simplifies the later operation by permitting

the abscesses were drained in the office and operation deferred until after the confinement.

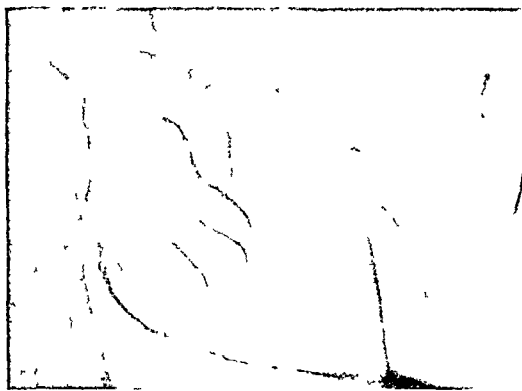


FIG. 3. Pilonidal sinus showing cribriform openings and abscess formation.

more accurate dissection and securing clean cut lines of cleavage. If removal is done during the acute suppurative stage, there is much necrosis present, making neat block dissection difficult. Some of the cases thought to be osteomyelitis of the sacrum may have been those in which the necrotic process made the deeper portion of the cavity so friable that it could not be separated from the underlying periosteum.

The abscess may easily be opened in the office. It is rarely necessary nor is it advisable to infiltrate with local anesthesia. The skin may, if desired, be sprayed with ethyl chloride or a thin line of phenol spread to deaden sensibility. However it can usually be done without any anesthetic. A pointed blade with sharp side up is stabbed into the abscess. It is then withdrawn, cutting its full length from within the cavity out. This procedure is far less painful than pressing downward upon the suppuration.

Considerable foul-smelling pus will be evacuated with immediate relief. Rarely is there difficulty with hemostasis, but a small packing may be inserted to prevent oozing. Packing, if placed, should be removed the following day. The wound is kept clean and some mild antiseptic dressing applied.

We have seen two patients during pregnancy with abscesses developed in pilonidal sinuses. In both these cases



FIG. 4. The wound is left open after the sinuses have been removed en bloc.

Ordinarily, after ten days surgical removal may be undertaken. To be successful there must be wide dissection of the involved tissues, preferably en bloc. Some surgeons employ methylene blue or other dyes to outline the tracts. This is rarely necessary. In fact the use of dyes is misleading because the scar tissue is so thick that small lateral sinuses may not be stained.

The radical removal of a pilonidal sinus is a major surgical procedure which, except in the very small or latent cysts, is not adapted to office treatment. Spinal anesthesia (50 mg.) is ideally suited to this purpose. Local anesthesia is often impractical because of the extent of the dissection and the presence of scar and pus. Caudal block is not advised because of the involvement of tissue just at the site of the insertion of the needle. The prone position best suited for operation makes inhalation anesthesia difficult particularly as the individuals tend to be fat.

Probes are passed through the sinuses upward to their full length. The palpating finger as well marks the apparent extent of the involvement. Beginning cephalad an elliptical incision is made pointed at both ends. After cutting through the skin the

fat is dissected well back on both sides. The tissue to be removed is steadied by an Allis forceps. The area is vascular and hemostasis should be controlled as the dissection proceeds.

When the sacral aponeurosis is reached the involved tissue can usually be separated by light, sharp dissection aided by gauze or the finger. If a definite line of cleavage can be maintained, the operation will be quicker, cleaner and the end result more sure. Chopping, tearing, and piece-meal dissection should be avoided if possible. About mid-way down the sacrum a branch of the middle sacral artery will be encountered that usually requires ligature by needle through the fascia and periosteum. After the block has been removed, all bleeding points are tied and the wound carefully inspected for any suspicious bits of sinus. If found, they are excised.

Many ingenious methods have been devised to correct the gap left by the cyst removal. These methods include complete primary suture with or without drainage; partial closure; plastic flaps; transplantation of portions of the gluteus maximus; marsupialization of the cyst wall, and others. These technics, in the hands of their devisors, are reported to work successfully. However, taken by and large, the most happy results have come from the open method. Kleckner,<sup>5</sup> in 1936, canvassed the members of the American Proctologic Society and the returns indicate that 87 per cent of these men with wide experience preferred the open method.

Rogers,<sup>6</sup> in 1933, analyzed a series of 119 patients treated over the years in the Massachusetts General Hospital. The matter of recurrence was particularly studied. In cases closed by primary suture, recurrence occurred in 36 per cent; with partial closure, 50 per cent; whereas those left for open healing recurred in only 18 per cent. Primary suture attempted in recurrences failed in every case. As part of the study, the patients were interrogated as to their satisfaction with the treatment, and it is interesting to note that those with

primary suture complained of itching, pain, irritation, numbness and tenderness in the scars to a greater degree than did those whose wounds were allowed to heal by the open method.

It has been my practice to leave the wounds open. While the time of healing may in this way be prolonged, the end results have been very satisfactory. During the postoperative course, should any signs of recurrence or unhealthy granulations appear, the involved area can be cauterized either by some chemical agent or by the fulgurating needle.

Accordingly, after the surgical dissection has been completed, the wound is packed lightly with vaseline gauze and a tight bandage placed, adhesive straps being utilized to draw the buttocks together and relieve tension on the margins of the wound.

#### AFTER CARE

The vaseline gauze pack is left for forty-eight hours. It is then removed and a substitute dressing of 5 per cent mercuriochrome or other mild antiseptic is employed. There is considerable mucoid secretion for about two weeks. Then granulations fill in readily and the dressing becomes much less elaborate. Patients are asked to report to the office about twice a week where their progress is watched. It is important to keep the edges of the wound shaved. When epithelization of the wound edges has progressed, a powder dressing with thymol iodide or bismuth-formic iodide is advised.

By the open method complete healing varies from six to twelve weeks, depending on the size of the wound. After about two weeks there is little discomfort and except for wearing a pad the patient can perform his normal activities.

#### CONCLUSIONS

1. The nature and etiology of pilonidal sinus is discussed, particularly with reference to its relationship to adolescence.

2. The indications and technic of open operation are described.

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PAIN as the result of posterior urethral disease usually is referred to the fossa navicularis or to the penoscrotal angle and is either of a burning or of a lancinating character. . . . Most of those cases in which the sensation is referred to the rectum, however, are in patients presenting some pathology of the sinus pocularis.

From—"Office Urology" by P. S. Pelouze (W. B. Saunders Company).

# PRURITUS ANI—AN ALLERGY

## ITS DIAGNOSIS AND TREATMENT

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**P**RURITUS ani should be discussed with constraint and imagination. It is not a specific disease; there is no known specific cause for it and no specific remedy. Like malignancy the problem remains unsolved and therefore its discussion is often controversial.

### DIAGNOSIS

*Descriptive.* Pruritus ani (itching of the anus) is the descriptive name given to a symptom; misnomers are "itching piles," "fissures," "eczema." The diagnosis depends upon the complaint of itching, usually worse at night, supplemented by evidence of perianal skin irritation; this may vary from a mild dermatitis (x) to the most extensive chronic thickening of the skin (xxxx), with abraded, often inflamed areas complicated by varying degrees of infection. The rugae or normal folds may be very much thickened. Pruritus rarely involves the anal canal; it may be found extending entirely around or extending from any part of the anocutaneous margin, more often posteriorly toward the coccyx and/or anteriorly on the perineum. The condition may extend on the scrotum; in women, the dermatitis may also involve both major labia and occasionally the pubis.

*Differential.* Pruritus ani should not be confused with irritated anal tags nor any of the following conditions that may itch: tickling or a crawling sensation from hypertrophied papillae; fissure, pin worms nor any transient itch of a few days. It must not be confused with trichomonas vaginalis, irritations caused by perspiration—chafing nor hypogonadism as evidenced in pruritus vulvae with extension to the anus.

Out of one hundred patients who present themselves for treatment, 75 per cent should respond to almost any rational palliative care. This accounts for the multiplicity of remedies and "cures" reported. Such usually conscientious reports are based on a fortunate few cases. It is the other 25 per cent that require every consideration; some of these patients are never cured; some develop neuroses through loss of sleep and rest; occasionally one will commit suicide.

*Etiologic.* Allergy, idiosyncrasy and hypersensitivity are words susceptible of broad interpretation and application with shaded but similar meanings. Their discussion as applied to the perianal region should embrace most of the known etiologic factors of pruritus ani.

Attacks may be induced and continued by a peculiar individual sensitivity to foods, organic matter, such as the secretions of bacteria harbored in anal crypts, fungi (dermatomyces), wool, chemicals as represented by some dyes, synthetics,<sup>1</sup> and drugs. Eczema at the anus may be an allergic response or a specific avitaminosis (B complex).<sup>2</sup> Endocrine imbalance must be thoroughly investigated. As seen during or after the menopause or menstrual cycle, itching suggests a sensitization to some transitory hormone.

Brooke<sup>3</sup> points out that the bacterial theory does not conform to Koch's law, and submits a convincing pathologic study in support of allergy.

I find Andreson's<sup>4</sup> recent discussion of "Allergy Manifestations in the Colon" helpful in the study of pruritus ani. Epitomizing some of his statements: some of the very marked anal and rectal condi-



tions with infiltration, ulceration and bleeding have been found to be allergic in origin; changes showing mild hypersecretion and edema are usually associated with pruritus, and can be traced to an allergic cause. With the history constituting the most important single diagnostic aid, one should look for a family history of allergy, but not necessarily of the same type as exhibited by the patient; recurring illnesses such as asthma, hay fever, migraine, eczema, urticaria, either experienced by the patient, his immediate relatives, his children or ancestors are very suggestive. The onset or cessation of symptoms at puberty or at the menopause, during pregnancy or after some great emotional stress require allergic study. When definite symptoms follow the ingestion of certain foods, such as milk followed by diarrhea, or abdominal cramps after eating mixtures like fruit salads, salad dressing or soups, one or more of such ingredients may be suspected as factors. That situation would be suggestive if pruritus ani were present. In the determination of food allergies in the colon the skin sensitization tests have been practically abandoned; the only real test is the keeping of careful records or repeated trials of a suspected food. That food to which a person is sensitive will always produce symptoms even in small quantities, and if symptoms fail to occur, even after the single ingestion of a food, that particular food may be absolved of blame for previous or subsequent symptoms. Sensitivity to a given food may disappear, and when it does it may be followed by sensitivity to a food previously innocuous; this should be borne in mind when improvement follows the elimination of a certain food, and later there is exacerbation or recurrence.

A serious attempt should be made to discover the sensitizing agents; careful historical inquiry, and a persistent one, may quickly reveal at least one. Grapes in any form, for instance, will induce violent allergic pruritus ani in some individuals which may require weeks to cure; having discovered the sensitizing agent, the sec-

ondary infection or dermatitis requires care. Salt, canned fish and shell varieties of sea food may be allergic agents; one must suspect almost any food or drink. Flaxseed (linseed) used by hairdressers has been known to cause pruritus ani to "itch worse"; such patients should disclose a positive scratch or patch test. Karaya<sup>7</sup> marketed as a laxative bulk producer has been found to be an activator. Many other specific instances could be mentioned.

Sensitization or allergic reaction to fungi undoubtedly plays an important role in pruritus ani. The focal infection should be sought as a dermatitis, and may be located on any part of the body. *Trichophyton* "UFA," Lilly, affords an encouraging means of diagnosis and treatment. If the intradermal test is positive, desensitization with this preparation should be tried.

This localized and persistent itching presents a diagnostic problem, the tentative name of which may well have been "idiopathic" pruritus ani.

#### PROCEDURE IN TREATMENT

The steps in the treatment are as follows: (1) Story or complaint, (2) physical examination, (3) anorectal and colonic examination; (4) palliative treatment; (5) technical study: (a) blood test (Kahn); (b) complete count; (c) hemoglobin percentage; (d) urinalysis; (e) patch tests and/or scratch tests, as suspicion warrants; (f) search for food allergens; and (6) surgery.

It must be remembered that the patient comes first for relief; this should be secured as far as possible by local applications, sedatives, anodynes and, when necessary, he should be required to stay in bed at home or preferably in a hospital where the complete study may be continued. Then sedation from bromides or barbiturates should be prescribed with added anodynes, ranging from aspirin to morphine as is necessary. The patient must have relief. The local application of equal parts of lime water and sweet oil (carron oil) is excellent. Following rest and the return of poise, 5 per cent—no stronger—silver nitrate solution

should be applied by a cotton applicator. This treatment should result in about 50 per cent improvement. Silver solution may be used successfully every second day until the abrasions are healed, but it should be supplemented by a proved antipruritic or anesthetic ointment.

There are a confusing number of other applications that have proved helpful and often it is desirable to substitute one or more of them. Among these are pure ichthyol warmed for handling, 2 per cent gentian violet, calamine lotion, carbolic vaseline: 1:10000 solution of permanganate of potash ( $\text{KMnO}_4$ ) as an enema as well as an application.

**Vitamins.** When one considers the increasing knowledge of avitaminosis as represented by pellagra, scurvy and eczema, a tentative explanation suggests that certain vitamins maintain a normal physiologic balance, the loss of which permits manifestations often called allergy.

A balanced high caloric diet—4500—is supplemented by a standard vitamin (ABCDG) capsule t.i.d. For increased B complex, dry powdered brewers yeast is suggested, about two ounces daily; this may be mixed with six ounces of peanut butter or catsup for palatability as suggested by T. D. Spies<sup>6</sup> in a succinct discussion of vitamin therapy.

Following the suggested palliative care, marked improvement should have resulted. This is a critical time; a meticulous explanation of the further problem and importance of finding the allergen should be given. And let me urge that the patient and the physician be persuaded to continue the search before masking the symptom—pruritus—by surgery or anesthesia. After reasonable time, however, all anorectal surgical conditions should be operated upon and a subcutaneous perianal neurotomy should close the operation. If surgery is unnecessary and there are no patent crypts, hypertrophied papillae, marked internal hemorrhoids nor anal tags, and if itching is not under reasonable control, one of the several oil soluble anesthetics should be

aseptically injected underneath the pruritic area. This is done in two or more stages if the condition is extensive. This procedure should afford relief from the itching for a variable number of weeks. Treatment of the perianal skin should be continued until it is as near normal as is possible, even after it ceases to itch. Pruritic patients should be given instruction as to the nonirritating care of the area, including direction to apply vaseline, cold cream or zinc oxide ointment every night indefinitely.

*Technique of Subcutaneous Neurotomy.* The entire perianal skin and that lining the canal is undercut through one inch bilateral incisions made outside of the pruritic area, completing first one side then the other. The skin is separated from the subcutaneous tissue with sharp scissors; it may be done principally with the knife. When necessary to undercut the skin of the anal canal, a finger is inserted as a guide. No hesitancy need prevent undercutting as much skin as necessitated by the extent of the pruritus. This severing of the cutaneous nerves is easily accomplished through the two incisions except when the labia and super pubic areas also require neurotomy. The considerable temporary bleeding needs no unusual attention. The nerves do not regenerate for several weeks and no packing nor drainage is necessary. This is strictly an aseptic procedure and no complications need be apprehended. The area will probably be "black and blue" for several days.

#### COMMENT

Mere knowledge of anorectal and colonic diseases is not sufficient to practice modern proctology. One must be thoroughly trained in surgery, have a reading knowledge of internal medicine and be familiar with allied and contributory conditions.

Diabetic patients are said to complain of pruritus and occasionally this may be true. If such complication does not clear up with proper diabetic treatment, its continuation may be due to an accompanying secondary infection or to a specific allergic response

which may have nothing to do with the diabetes.

Hypothyroidism is occasionally accompanied by a mild pruritus ani, and when suggested by a physical appraisal—low blood pressure, unusual fatigue, dizziness—a metabolism test or a therapeutic test will determine the diagnosis and adequate thyroid administration should follow.

Anthony Bassler,<sup>7</sup> confirming Murray's work on the relation of the *Bacillus fecalis* to pruritus ani, reports excellent results and gives specific directions for its treatment with vaccine. I believe his results are secured by desensitizing the patient with vaccine. These bacilli are often found when there is no evidence of pruritus ani which supports my conception of allergy. The same deductions may be made when patent crypts are present. In my opinion, they do not cause pruritus ani unless the host is sensitized to some of the bacteria or their secretions which are always present. Kallet reported to me the history of a man who was sensitized to some ingredient in hemorrhoidal suppositories, the patch test being very positive. His local irritation disappeared when the use of these suppositories was discontinued.

Beware of confusing chemical irritation with an allergic reaction. Glycerine suppositories as used in children particularly, cause a sustained local irritation in many of them. A patch test should determine whether it is due to idiosyncrasy or chemical irritation.

Violet ray treatment of pruritus ani is to be condemned since the effect is to aggravate the condition.

Roentgen ray treatment was accurately outlined by Kallet<sup>8</sup> in 1938: "Satisfactory palliation in most instances—" It has its place.

Histaminase is affording interesting development in its relation to allergy.

I prefer perianal neurotomy or the injection of an oil soluble anesthetic to the devastating complications that result from injecting alcohol.

Many treatments have been tried and discarded, while others are still in the experimental stage. Among the latter is the novel procedure of tattooing<sup>9</sup> mercury succinamide or sulphide into the involved skin; this has been suspected of irritating the kidneys. The objective seems comparable to iontophoresis.

#### CONCLUSION

In representing my conception of pruritus ani, I realize that a complex diagnostic problem is presented. However, if a solution is to be found, advantage must be taken of the modern research in physiology and biology.

Courtesy of The Year Book Publishers, Chicago, from a manuscript in preparation.

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# POLYPS OF THE RECTUM\*

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A DISCUSSION of this subject seems important for three primary reasons: The incidence of the condition is higher than generally supposed; the marked tendency for these tumors to undergo malignant degeneration is not sufficiently appreciated, and the majority are amenable to office measures of treatment.

A polyp can be defined as any pedunculated or sessile growth projecting into the lumen of the bowel, either the result of hypertrophy or hyperplasia of the mucous membrane, or else as a benign true tumor.

These growths in general may be classified as follows:

A. True benign tumors

1. Lipomas
2. Fibromas
3. Leiomyomas
4. Adenomas
5. Angiomas

B. Adenomas

1. Single
2. Multiple

C. Multiple polyposis—also called polypoidosis (Broders)

Multiple polypoid disease (Buie)

1. Congenital type
    - a. Adolescent (Erdman) or polyposis universalis (Susman)
  2. Acquired type
    - a. Adult (Erdman), polypi (Susman)
    - b. Postinflammatory—called polyposis cystica intestini (Felsen)
- Pseudo-polyposis (Rankin)  
Colitis polyposa (Virchow)

As is evidenced from the above outline, the nomenclature within the multiple polyposis group is much confused, many

of the different investigators having coined a word which they feel best describes the condition. The congenital type includes those cases usually appearing in adolescent or early adult life in which a strong familial trait is evident, and which gives no history of previous inflammatory or ulcerative disease. The acquired type of multiple polyposis designates those cases which follow extensive inflammatory disease such as ulcerative colitis, bacillary dysentery, amebiasis and tuberculosis of the colon.

The true benign tumors are relatively rare and are listed only because they must be considered in the differential diagnosis of any colonic tumor; otherwise they are outside the scope of this paper.

As suggested in the introduction, the incidence of polyps in the rectum is higher than is generally supposed. Stewart found polyps in 4.19 per cent of 1815 consecutive autopsies, while Susman in a careful search of each specimen, found sixty-five simple or multiple polyps and one case of disseminated polyposis in 1100 autopsies, or an incidence of 6 per cent.

From the clinical side, Buie reported seeing 1234 patients with some type of polypoid disease of the colon at the Mayo Clinic in a ten-year period. This amounted to one patient in thirty-five of those complaining of disturbed bowel function. Of these 86.5 per cent had only one or a few polyps; 9 per cent were associated with chronic ulcerative colitis and 4.5 per cent were of the diffuse congenital type. The average age was about 50 in the solitary group and 31 in the congenital and post inflammatory group. Approximately 70 per cent of all colonic polyps occur in the rectum.

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Hypertrophied anal papillae, which may take on a polypoid form, are anal lesions and hence are not included in this discussion. Furthermore, they are not of adenomatous nature.

There are two main schools of thought concerning the origin and development of these tumors. The theory first formulated by Ribbert is the more generally accepted but is losing ground as more evidence becomes available. He was of the opinion that the polyps originated from embryonal cell rests which may remain unaltered or become activated either by local irritation or from constitutional changes. The other view places the main emphasis on local inflammatory causes, but does not exclude some analogue peculiar to the individual.

Gray has reported a well studied case in which allergens were the cause of bowel symptoms in a case of polyposis, as all symptoms were promptly controlled on their removal and periodic barium enema studies showed a gradual disappearance of the polyps themselves.

The observations by Hoelzel and Da Costa on the colons of rats in which they were trying to produce duodenal ulcers by using high roughage diets seem to me of great importance in this question of etiology. They observed varying degrees of polyposis of the colon in 34 per cent of 250 rats. They felt that the intestinal stasis produced by such diets was the main causative factor.

Pathologically, the lesions are adenomatous outgrowths of the mucosa of the colon or rectum into the bowel lumen. They may be sessile or pedunculated, smooth surfaced or papillomatous. The core or stalk is made up of vascular connective tissue covered by thickened mucosa, surrounded by a head which consists of a mass of adenomatous tissue of columnar cell type. The pedicle is produced by the tug of peristaltic action and the effect of the fecal current itself.

Histologically, polyps associated with chronic ulcerative colitis and bacillary dysentery are identical with other types when well developed, but their process of

formation has no doubt, been quite different. They represent islands of swollen mucosa or small strips left surrounded by areas of ulceration. As healing takes place these take on definite adenomatous characteristics. It is interesting to note that if these growths do become malignant the grade of malignancy is usually higher than in those of the congenital type.

Several attempts have been made to classify colonic polyps on the basis of their histologic structure with a view to determining those most likely to undergo malignant change. Both Fitzgibbon and Rankin's and Schmieden and Westhues' classifications are worthy of note but the pathologic distinctions in the latter grouping seem more clear cut:

*Group I.* Polyps the size of a cherry to a walnut; usually solitary; often found in children; pedunculated; rich in stroma and with gland formation. No anaplasia is present. These rarely turn malignant.

*Group II.* Single; organoid in type; variable in size, but may reach the size of an apple. The stroma is in papillary form. The glands are elongated and irregular, with epithelium showing active proliferation. Anaplasia begins in the center or periphery and spreads laterally. These usually become malignant.

*Group III.* Variable in size; usually small and multiple; sessile; highly anaplastic and disposed to penetrate into the gut wall. This group always becomes malignant.

Practically, while the tip of a polyp is most likely to be the first site of malignant change, whether or not the pedicle is involved is the most important fact in planning treatment. Clinically, a sessile polyp over 1 cm. in diameter is to be regarded as dangerous.

Manheim and Druckerman's recent report is the only case on record in which one solitary polyp was traced by tissue studies from a benign state to one of definite malignancy. Yet the circumstantial evidence that this is of relatively frequent occurrence is overwhelming. These studies are from two different view points: First, the incidence of carcinoma in polyp cases averages about 30 per cent, varying from 23 per

cent in Susman's series to 45 per cent in Yeoman's; conversely, the incidence of polyps in specimens of carcinoma averages 42 per cent. It would seem only axiomatic from these studies that the greater the number of polyps the greater the likelihood of malignant change.

The symptoms produced by polyps and polyposis vary with the degree of involvement, but are absent or negligible all too frequently. The masses are usually discovered on routine examination. The passage of blood and mucus is the most frequent sign. The blood is usually fresh, with or following stool, and not in large amounts. Diarrhea is the next most important complaint. This is intermittent at first, becoming progressively more severe. Tenesmus is proportional to the proximity to the sphincter and the size of the mass. Pain, if any, is crampy and intermittent unless the polyp has prolapsed outside the sphincter. Nausea is rare except with higher degrees of obstruction. Loss of weight is a late manifestation and is due to diarrhea, obstruction or malignant degeneration. Anemia is proportional to the blood loss. Obstruction is encountered not as frequently from the size of the growth as from the sudden production of intussusception. Several of such cases have been reported. The tumor may prolapse if it is situated low down and has a long pedicle, but recently a prolapsed case was seen in which the pedicle was attached in the sigmoid ten inches from the anal orifice. This tendency for the polyp to prolapse is more common in children in whom the supports of the rectum are weaker and the tissues more elastic.

The diagnosis is usually made by direct examination. The personal history is only suggestive, but the family history is important in the cases of multiple involvement. Digital examination will disclose the low tumors, but if a long pedicle is present it may be mistaken for a hard fecal mass. Sigmoidoscopy will disclose at least 70 per cent of all colonic polypi. Those above the reach of the sigmoidoscope are shown by barium enema x-ray, especially when the double contrast method of Weber is used.

The larger tumors should be biopsied before deciding on treatment, but the small solitary polyps can usually be removed completely, easily and safely, especially if the tissue is sectioned at once.

#### TREATMENT

The palliative treatment of colonic polyposis should be used only while preparing the patient for the curative measures or when the latter is contraindicated. The palliative treatment may consist of a high caloric, soft, low residue diet with mineral oil if partial obstruction is present or if it is necessary to keep the fecal material of soft consistency. Any existing anemia should receive attention. Some relief of symptoms has been said to follow the use of enemas of a colloidal suspension of mercuric chloride. Bleeding may be lessened by an enema of acacia, bismuth and adrenalin. X-ray and radium therapy have been mainly unsatisfactory. With Gray's experience in mind, allergens may well be searched for and removed when found.

Fulguration through the sigmoidoscope for the 70 per cent of polyps which can be reached by this instrument is the treatment of choice. The growths with a pedicle can be removed easily with little or no danger of hemorrhage with the high frequency snare, using a slow cutting current, while the smaller and sessile growths are effectively destroyed by electrocoagulation. The greatest caution must be used in treating those growths lying above the peritoneal reflection so that the bowel wall is not pierced. In this respect, the high frequency snare and the bipolar electrodes are much safer than unipolar coagulation. The polyps over 3 cm. in diameter with a thick stalk should be removed in the hospital, as frequently a large artery will be encountered in the pedicle which may be hard to control. The other patients may, however, be safely treated in the office with proper equipment. A suction apparatus connected with a long nozzle to remove the smoke and keep the field dry greatly facilitates the work. No anesthetic is necessary or desirable unless it is for sphincteric relaxation

when an unusually large scope is required. Bed rest for the first forty-eight hours is preferable, and no strenuous exercise should be done for ten days.

The single polyps low down in the rectum may be excised with scissors and the base transfixed with a suture. The lesions beyond the reach of the sigmoidoscope require more radical measures and are hence outside the scope of this discussion.

#### CONCLUSIONS

1. The incidence of single and multiple polyps in the rectum approaches 3 per cent

in clinical practice and 5 per cent in autopsy material.

2. All polyps in the rectum are potentially malignant and the probability increases with the number present, approaching 100 per cent in the disseminated types of polyposis.

3. The diagnosis and treatment of the majority of rectal polyps is a safe office procedure with proper equipment.

4. The pedunculated polyps are best removed by the high frequency snare, while the sessile growths should be destroyed by fulguration.



THAT urethral polypi at times produce sensory impulses cannot be denied. The nature of these sensations varies with the location of the polyp pedicle.

From—"Office Urology" by P. S. Pelouze (W. B. Saunders Company).

# RUPTURE OF THE BLADDER

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**R**UPTURE of the bladder is nearly always due to trauma and is favored by vesical distention and pre-existing disease of the bladder wall. The distention is usually from a bladder neck obstruction, a stricture of the urethra or neglect of micturition particularly during drunkenness.

Trauma may be divided into internal and external: The external is due to falls and blows, while internal trauma is usually due to either straining at stool, micturition or parturition. Rupture of the bladder occurs most frequently in adult males, and the posterior superior portion of the vault of the bladder is very often involved because this section is its weakest part.

Rupture of the bladder may be complete or incomplete. In either case, early and speedy operative treatment is imperative. No operative procedure will be of any benefit without free bladder drainage. In incomplete rupture involving only the mucosa and submucous membrane, cystotomy is preferable to catheter in situ because of the danger of pelvic cellulitis which comes on insidiously and which, when evident, is too late to combat.

Rupture of the bladder may be intraperitoneal or extraperitoneal. Both of these types give similar symptoms, except that in the intraperitoneal type we are confronted with a more serious situation presenting the added symptoms of peritonitis. The differential diagnosis of the two is not of much importance since both require immediate surgical intervention.

In the intraperitoneal type of rupture the immediate symptoms are more or less severe shock, pain and a frequent desire to urinate with inability to do so. Frequently a few drops of blood are passed at each attempted micturition. The extravasation of urine may cause rigidity and

distention in the region of the bladder. With involvement of the peritoneum signs of free fluid appear in the abdominal cavity. Later symptoms of peritonitis cloud the clinical picture. The severity of the peritonitis depends on whether or not the urine is infected; if infected, the case may terminate fatally from toxemia in a short period of time. If we are dealing with an extraperitoneal rupture, a palpable mass appears within twenty-four hours with more or less pain in the bladder region. A palpable mass in one or both flanks indicates that the urine has dissected its way upward. With infection evidence of sepsis quickly follows.

The mortality rate is rather high. The earlier the diagnosis and operative treatment, the lower the mortality rate. The prognosis is much better if intraperitoneal rupture does not occur. In many instances the diagnosis is not very difficult, but pain in the lower abdomen, tenasmus, bloody urine and difficulty of urination should be sufficient to determine the probable presence of bladder injury.

In many instances rupture of the bladder is associated with injury to the pelvis. Diagnosis is made according to the history of the injury in the bladder region, the presence of shock, the inability to void and the presence of blood in the catheterized specimen.

Radiographic methods of diagnosis are employed but cystoscopy is practical and more readily applied. It gives a higher percentage of positive diagnosis. It certainly does not add risk, as some believe, provided, however, that the operation is prompt.

In making a diagnosis by radiographic method, the patient is told to void. If, however, the patient is unable to void, he should be catheterized and the bladder



filled with a 4 per cent sodium iodide or a 5 to 10 per cent hippuran solution. Filling should be stopped when the patient complains of discomfort. If the patient does not complain, it should be stopped at 300 cc. and this amount should be carefully noted. A series of cystograms is then taken, the patient being so placed that the entire bladder outline is shown. The films when developed will show an indistinct picture with extravasated dye outlining the ruptured bladder. If a catheter cannot be passed, a urethrogram should be taken to demonstrate the nature of the urethral injury.

Intravenous urography may also be employed. As a ruptured bladder is suspected or seems probable, skiodan is given intravenously. Five minutes after the injection of the dye, the first picture is taken, and ten minutes later, the second picture. These very often show an extravasation in the region of the rupture. When there is delayed renal function, later pictures are taken at fifteen minute intervals.

For diagnostic purposes simple catheterization without the injection of fluids or air is safer and usually sufficient. The use of a catheter at times may prove a failure with larger tears in the bladder wall. The catheter may drain the peritoneal cavity which may contain a large amount of urine, or then again the constant desire to void and the uncertainty of the amount voided nullifies its purpose to confirm an empty bladder. Where the tear is high and not large, it is possible to inject as much as 300 cc. of fluid and still recover the amount injected. This fact was revealed by one of our cases. In some cases the use of the cystoscope to locate the point of rupture proves fallacious, particularly when there is much bleeding and when the bladder cannot be filled sufficiently because of the size of the tear which offers poor visualization. In some cases fluoroscopic observation as a means of diagnosis is useful. Air is introduced through the catheter. With an intraperitoneal rupture the air accumulates at the highest point

immediately under the peritoneum when the patient lies on his side. If the patient then sits up, the air is seen to collect under the diaphragm. In extraperitoneal rupture the air spreads perivesically or into the abdominal wall. This method, however, may be dangerous because of spread of infection or air embolism. Contrast cystography may be useful in this procedure: The bladder is filled to a point of discomfort with a four per cent solution of sterile sodium iodide or dilute hippuran or some other dye, with 300 cc. as a maximum. The picture is then taken, the bladder emptied and finally refilled with air for the contrast picture.

Rupture of the bladder is as much a surgical emergency as is an acute condition within the abdomen. Delay is equally dangerous. The diagnosis should be made within a few hours and supportive measures instituted in the meantime.

Surgery consists of suprapubic exploration. When extraperitoneal exposure reveals no extravasation, the peritoneum is opened and a careful search made. The peritoneal surface of the bladder is examined for a tear and to determine the presence or absence of any pre-existing pathology of the bladder wall. A tear can be repaired and the peritoneal opening closed before opening the bladder. However, the rent in the bladder may or may not be sutured. In the author's opinion, it makes no difference either way unless the rent is too large. Of course, the operative procedure depends on the condition of the bladder wall. A diseased wall should be resected and closed tightly, but whatever procedure is employed suprapubic bladder drainage is always indicated.

In vesical rupture a careful history and physical examination are very important and in many cases are sufficient for a positive diagnosis without the aid of x-ray or instruments. Symptoms such as suprapubic pain, bloody urine, an empty or nearly empty bladder with abdominal rigidity or free fluid with a palpable mass are usually present.

## SUMMARY

In rupture of the bladder, whether complete or incomplete, intraperitoneal or extraperitoneal, the diagnosis should be made within a few hours followed by prompt operative treatment. In many cases a careful history and physical examination are sufficient for the diagnosis. Diagnosis by use of the catheter is generally unreliable; extreme caution should be observed in evaluating findings from its

use. The cystoscopic method of diagnosis is most reliable and gives a higher percentage of positive diagnosis. It is preferable to the radiographic methods; in fact, from a practical standpoint, the use of the cystoscope surpasses all other methods of diagnosis.

The earlier diagnosis is made and operative treatment instituted, the lower the mortality rate. The mortality rate is highest in the intraperitoneal rupture, particularly when septic peritonitis supervenes.



BLADDER pain varies from the slight discomfort of trigonal congestion to the intense, agonizing pain of acute distention. It may be continuous or intermittent, aching, burning or lancinating.

From—"Office Urology" by P. S. Pelouze (W. B. Saunders Company).

# POSTOPERATIVE PAROTITIS\*

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IN spite of the many careful studies that have been made on the subject of postoperative parotitis, its etiology is still obscure. Although not particularly common, parotitis is an unpredictable and dangerous postoperative complication and is sufficient in frequency and importance to merit consideration.

## INCIDENCE

Studies of the incidence are confusing, as parotitis occurs in general surgery in from one in 800 to one in 10,000 cases. The incidence in general surgery at the Cleveland Clinic was one in 1500 cases. We have found that certain intra-abdominal operations carry with them a higher incidence of parotitis than others. At the Cleveland Clinic Hospital, colon surgery showed an incidence of one in 125, which is comparable with the report of Rankin and Palmer<sup>9</sup> who give an occurrence of one in 135 cases of colon surgery. Over half of the cases of parotitis in our series occurred following colon surgery, 65 per cent of these cases complicating the postoperative course of patients having abdominoperineal resections of the rectum, making the incidence in that procedure one in twenty.

## ETIOLOGY

Since parotitis was first described in 1834, several theories for its etiology have been presented. Among these are:

1. Sympathetic—a relationship between the parotid gland and the generative organs.

2. Heat degeneration—hyperpyrexia causing a breakdown of gland substance.

3. Toxin excretion theory—failure to excrete the toxins present in the gland during a generalized disease.

4. Lymphatic—a possible cause, but presupposes an infection in the parotid area.

5. Traumatic—caused by trauma over the gland.

6. Abdominal reflex—based upon the fact that the action of the gustatory nerve is inhibited when a loop of intestine is drawn from the abdominal cavity.

7. Hematogenous—a theory widely held today, that postoperative parotitis is due to a septic thrombus.

8. Ductogenous or ascending—a direct extension of organisms from the mouth.

Modern opinion favors the ductogenous theory. Although there is no reason that hematogenous infection should not occur, it is difficult to produce indisputable clinical and bacteriologic evidence that such is the case.

Studies were undertaken to confirm the findings of those who stated that the terminal third of Stenson's duct normally contains organisms which are predominately staphylococci. Smears and cultures of the parotid ducts and the alveolar border opposite the orifice of the duct were taken in twenty-five normal individuals. Staphylococci were present in the majority of cases; the culture was sterile in only one-half of the cases. In order to determine the effect of poor oral hygiene on the concentration of staphylococci in Stenson's duct, ten patients who were considered to have foul mouths were subjected to the same procedure. Both smears and cultures showed that the ducts contained about twice the number of staphylococci and that the cultures were sterile in only a third of the cases.

Cultures were taken from the mouths of individuals before and after operations and severe illnesses. The staphylococci present only in small numbers before operation

\* From the Cleveland Clinic.

became more numerous after operation. When the mouth did not become dry and when proper postoperative oral hygiene was given, the organisms did not increase in number. An interesting fact was that the sublingual region contained only a few such organisms. This, perhaps, can be attributed to two factors: (1) the incessant motion of the tongue keeping the area clean, and (2) the fact that the submaxillary gland contains mucin in its secretion, a substance which has been proved by Seifert<sup>11</sup> to be a bactericidal agent both in vitro and in vivo.

Wolbach and Bessey<sup>12</sup> have shown that vitamin A deficiency causes atrophy of the epithelial lining cells of many of the epithelial structures, including the salivary glands, genitourinary tract, respiratory tract and the eyes. Following atrophy, proliferation of basal cells was seen which produced stratified epithelium of keratinized cells in place of the normal columnar epithelium. Such metaplasia often would result in the accumulation of desquamated cells in the acini and ducts of the various organs and would tend to occlude the ducts. Since Stenson's duct normally contains bacteria, it was logical to presume that in the presence of epithelial changes and possible occlusion and stasis, infection might easily occur and parotitis might quickly follow. Therefore, a group of cases with colon disease was studied to determine whether or not a deficiency of vitamin A might be a factor in the production of the high incidence of parotitis in these cases.

Twenty-two patients having carcinoma of the colon were tested for dark adaptation by the Frohring apparatus. Sixteen had a reading which showed a definite deficiency of vitamin A. Postoperative parotitis developed in five of the sixteen patients, and postoperative pneumonia developed in three. In the six cases having normal biophotometer tests, the only complication that occurred was a single case of pneumonia. Although this experience is too small to allow us to draw any conclusions, we are continuing to study all cases sub-

jected to colon surgery and to test them for vitamin A deficiency.

#### REVIEW OF SIXTY CASES OF PAROTITIS

The average age of the sixty patients who developed postoperative parotitis was 50½ years. The sex was evenly divided and the season of the year seemed to play no part. The parotitis was first observed between the first and the eighteenth postoperative day, the time of onset of the average case being on the fifth postoperative day. The side involved was not significant, for a third were bilateral and in the remaining two-thirds each side was involved in an equal number of cases. A careful survey of the general condition of the patient indicated that forty of the sixty were in good condition, eight in fair condition and twelve in poor condition.

The duration of the operation played no part in the development of parotitis.

Anesthesia was considered as a possible factor, but over half of the cases had spinal anesthesia and the remainder had a combination of local and nitrous oxide or ether and nitrous oxide anesthesia. Atropine was given in only twenty of the sixty cases.

In this series of cases, dehydration rarely occurred; the patients usually received adequate amounts of fluid parenterally. However, many patients were not allowed fluid by mouth until the second or third day and did not have the best possible postoperative oral hygiene or oral hydration. Parotid stimulation by forceful mastication, as by chewing gum, was not insisted upon immediately after operation.

High urea estimations existed in nearly every case of parotitis and incision and drainage of the gland often was accompanied by a recession of the level of blood urea. We believe, however, that the urea retention is associated with the toxemia and dehydration, and is more often the result than the cause of the parotitis.

It is interesting to note that pain over the temporomandibular joint upon opening the jaw was the earliest complaint of the majority of the patients with postoperative

parotitis; swelling first appeared six to eight hours later.

In summary, the chief factors in the production of postoperative parotitis are: (1) Oral sepsis and inadequate dental prophylaxis; (2) inhibition of salivation; (3) dehydration; (4) absence of mastication and failure of the attendants to provide proper postoperative oral hygiene; (5) vitamin A deficiency resulting in an alteration of the epithelium and a lowering of its resistance to infection; and (6) a peculiar tendency for parotitis to occur following colon surgery.

#### MORTALITY

A review of the literature reveals widely differing mortality rates. Mortality rates are given on the basis of gross mortality in some series, as well as on actual mortality from the complication itself. In our series there were fifteen deaths, three definitely caused by parotitis, two in which parotitis was a definite contributory factor, and ten in which parotitis played only a small rôle in the death of the patient. Although death from parotitis alone is rare, we believe that parotitis contributes to death when it is the chief factor responsible for the terminal depression. The mortality is increased markedly if incision and drainage is necessary, whereas prompt and adequate treatment, particularly deep roentgen therapy, seems to reduce the mortality. Incision and drainage was performed in twenty-three cases, with a mortality rate of 43 per cent; thirty-seven patients were treated without operation, with a mortality rate of 11 per cent.

#### TREATMENT

In postoperative parotitis, as in any other condition in which the actual causative factor is unknown, treatment has been variable and a multitude of therapeutic measures have been advocated. Treatment includes three essential points: preoperative preparation, postoperative care and active treatment if the complication develops.

Prophylaxis includes hydration, oral cleanliness and the assurance of no existing

vitamin A deficiency. The fluid intake of the patient should be maintained at a normal level. Transfusion, particularly in an individual with carcinoma, often is of value. Careful and thorough dental prophylaxis is usually indicated. The preoperative medication should be designed to avoid general depression and depression of salivation. General vitamin therapy should be given in all cases of colon disease. Since vitamin A deficiency is considered to be a possible factor in the production of parotitis and if a known deficiency of this vitamin exists, large amounts of vitamin A should be given prior to operation.

Postoperative care should include hydration, oral hygiene and stimulation of salivation. Stimulation of salivation by simple chewing is one of the most important prophylactic measures because such mechanical cleansing of the duct obviates bacterial stasis. Chewing of gum should begin within the first twenty-four hours after operation. Although the use of lemon candy may stimulate salivation, we do not believe that its prophylactic value is equal to that of forceful mastication. Vitamin therapy should be given parenterally until the patient is able to take vitamins by mouth. Vitamin A, while not yet generally available for parenteral injection, should be given as soon as possible.

Because it is impossible to determine whether or not the parotitis will subside or will suppurate, at first it is necessary to treat all active cases alike. Once postoperative parotitis is known to be present, the following measures should be instituted immediately:

1. *Active Mastication.* The patient must be urged to chew gum. Although pain exists, chewing must continue.

2. *General Supportive Measures.*

3. *Sulfathiazol.* This drug favorably influences the course of staphylococcal infections and has been of value in several cases of parotitis in which it has been used.

4. *Roentgen or Radium Therapy.* Radium has been used by some and is of value, but in our opinion roentgen therapy is the treatment of choice if given imme-

diately after the determination of the presence of postoperative parotitis. The value of roentgen therapy is diminished if given after the first few hours of the onset of the complication. Treatment may be given with any portable machine whose output is known, and requires application for only a few minutes. Generally only 200 to 400 r units are required, giving approximately one-half skin erythema dose, but it is not harmful to give as much as five treatments each of 200 r units over a period of ten days. The value of roentgen therapy is increased because of its ready availability, its rapidity of application and the ease of proper control and concentration.

5. *Incision and Drainage.* If roentgen therapy has failed and if the patient has not shown clinical improvement, it occasionally is necessary to incise and drain the gland. Most cases should be observed for from five to six days before surgical intervention. The incision need not be large, as adequate drainage can be obtained through a small incision if the capsule of the gland is broken and the abscess drained.

#### SUMMARY

1. Postoperative parotitis is a frequent and important complication of colon surgery.

2. Death from parotitis alone is rare but the additional burden of this complication may be the factor precipitating an unfavorable end result.

3. The majority of infections probably are ductogenous in origin, and the responsible organism is the staphylococcus.

4. It is logical to regard the presence of postoperative parotitis as evidence of decreased resistance to organisms frequently present in the mouth.

5. Vitamin A deficiency with attendant atrophy of the epithelial cells of Stenson's duct may be responsible for the lowered resistance of the parotid gland. Occlusion of the duct secondary to salivary stasis is possible because of the accumulation of keratinized cells produced during the process of metaplasia.

6. Staphylococci exist normally at the

terminal third of Stenson's duct. Oral hygiene seems to govern the concentration of such organisms.

7. The biophotometer test indicates the presence or absence of sufficient vitamin A in the system. If a vitamin A deficiency is shown to exist, it should be corrected.

8. Preoperative care should include hydration and oral hygiene.

9. Postoperative prophylaxis should consist of continuance of oral hygiene, hydration and the institution of active mastication as soon as possible.

10. Treatment after parotitis has developed should include roentgen therapy applied immediately, regardless of the hour or the condition of the patient. Sulfathiazol, whose action against the staphylococcus might prevent bacteremia, should be given.

11. Incision and drainage usually is not required.

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# FRACTURES OF THE NASAL BONES\*

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THE great importance of the proper treatment of nasal fractures, both from the cosmetic and functional standpoints, is all too frequently underestimated by the attending physician as well as by the patient himself. This neglect is apparently due to a lack of realization of the handicap produced by nasal disfigurement and the fact that the edema of the adjacent soft parts hides the displacement of the fragments.

An undesirable deformity becomes a matter of considerable economic and social as well as psychologic importance to the patient, especially when the economic and social competition of today is considered. The patient may become "appearance conscious" and refrain from all social activity. It therefore is imperative that fractures of the nasal bones receive immediate care. At this time their correction is relatively simple. Once the deformity has become well established, it can be remedied only by a difficult plastic operation.

Particularly to be condemned is the neglect of a fractured nose in a child, as any correction of a neglected deformity must wait until the nose has reached its full growth, which is approximately at the seventeenth year. In the meantime, the child must tolerate the discomfort of nasal obstruction and its sequelae, as well as the frank comments of his associates.

The management of simple fractures has not changed appreciably in the past few years.

*Anatomic Considerations.* The nasal bones are two quadrilateral, not triangular, bones which form the upper half of the bridge of the nose. They articulate above with the frontal bones, medially with each other, the perpendicular plate of the ethmoid and cartilaginous septum, laterally with the nasal processes of the maxillae,

and below with the upper lateral cartilages. Any injury causing fracture of the nasal bones is almost certain to affect some of the adjacent structures.

## CLASSIFICATION OF NASAL FRACTURES

Almost all nasal fractures may be grouped as either the median or the lateral type. In the median type, the blow generally is struck in the midline directly from in front. The type of fracture will vary with the nature of the blow:

1. If moderate, the fragile inferior edge of the nasal bone may be fractured.

2. If the blow is somewhat higher, the nasofrontal articulation may be separated and the inner bony arch may be displaced and impacted. Because the nasal spine itself is supported posteriorly by the vertical plate of the ethmoid, there is a continuity of bone from the bridge to the crista galli which explains why a blow on the nose can force the perpendicular or the cribiform plate of the ethmoid upward into the anterior cranial fossa. This is more true with increasing age since the articulations become firmly ossified to form one solid mass of bone which at times transmits the force of a blow from one end to the other.

3. The force of the blow may be great enough to cause comminution of the nasal bones and flattening of the entire arch. The bony septum again is subjected to considerable trauma. At the same time, the nasal processes of the maxillary bones may be depressed. In this type of fracture, a definite ridge can be felt at each side of the nose.

In the lateral type of fracture, a blow to the side of the nose may fracture only one nasal bone, resulting in depression of that side of the nose, or the entire bony arch may be separated from its attachment at the base as well as from the nasofrontal

\* From the Cleveland Clinic.

suture and may be deviated to one side. In this type of fracture a depression of the nasal bone and possibly of the adjacent part of the maxillary bone is found on the side the blow was struck, and the opposite bone will be displaced toward the other side. An attempt to push the opposite bone inward should not be made until the depressed bone or bones are elevated and replaced.

Injury to the lateral cartilages or to the cartilaginous septum may occur independently or in connection with bony fractures. Dislocation of these cartilages often leads to nasal obstruction or to external nasal deformity. These conditions resist immediate treatment, and often require a secondary operation for their correction.

Fractures of the nasal bones frequently are compound; that is, the bones protrude through the skin, the mucous membrane or both. Infection, however, usually fails to develop, but if the patient blows his nose, occasionally the rent in the mucous membrane allows the development of a subcutaneous emphysema with its characteristic crackling sensation on palpation in the tissues about the nose, eyes and lower forehead.

*The Nasal Septum.* The tearing of the septal cartilage at some of its attachments may be evident as a marked dislocation immediately after the injury, or no change may be seen until long after the injury when a ridge caused by inflammatory thickening is found along the previously loosened border. The septum may be dislocated from its attachment to the superior maxilla and may deviate in one nostril or the other. The most common dislocation occurs at the junction of the cartilage of the septum with the vomer and the ethmoid.

Fractures usually occur in the posterior two-thirds of the cartilaginous septum and in the anterior half of the bony septum. Fractures of the nasal bones with little displacement may produce no change in the septum. Even with considerable depression and comminution of the nasal bones the septum may appear to be unchanged, al-

though there may be bowing or tearing at the seat of the fracture.

Fractures of the septum sometimes are classified as horizontal or vertical. A horizontal fracture is the most common and produces a groove-like deformity roughly paralleling the floor of the nose. A convexity appears in one naris and a concavity in the other. A vertical fracture may occur anywhere in the course of the cartilaginous septum; but when it is situated well back, it must be distinguished from dislocation of the cartilage.

#### SYMPTOMS AND SIGNS

1. Pain usually is not marked, but if present, it is caused by congestion of the mucous membrane of the nose, combined with blockage of drainage from the various sinuses.

2. Epistaxis occurs frequently and is caused by the rupture of the delicate nasal mucous membrane by the bony fragments. It may be unilateral or bilateral. It may be slight and cease spontaneously, or it may be severe enough to exsanguinate the patient unless arrested.

3. Nasal obstruction may result either from the accumulation of blood in the nasal passages or from the fracture or dislocation of the septum with swelling of the mucous membrane. Occasionally, a hematoma of the septum will produce obstruction.

4. Ecchymosis is due to the subcutaneous extravasation of blood and usually appears within a few hours after the injury. It is most marked in the eyelids and may be severe enough to close the eye. The severity of the hemorrhage and swelling usually increases for forty-eight hours and then subsides. Almost all of the discoloration disappears within two weeks.

5. Bony crepitus usually can be elicited by digital manipulation of the nose. Its absence, however, does not signify that a fracture is not present.

6. The presence of emphysema generally is definite evidence of involvement of one of the nasal sinuses. However, blowing the



nose may force air beneath the skin through a tear in the mucosa.

7. External deformity is not apparent unless the nose has been deviated from the midline or has been crushed inward, depending on whether or not the blow was from the midline or from the side. Slight deformity frequently is masked by the swelling and ecchymosis and may easily be overlooked.

8. Internal deformity in the nose includes (1) deviation, dislocation or fracture of the septum and (2) obstruction of the air space on one or both sides by swelling of the mucous membrane, hematoma of the septum or compression of the bony framework.

#### DIAGNOSIS

The diagnosis can be made from the history, symptoms and signs, except in cases in which the fracture is very mild and when edema or swelling of the soft tissues is slight and no external deformity is apparent. Frequently a mild case in which there is ecchymosis of the orbit is falsely ascribed to simple contusion of the soft parts. However, in such instances there always is localized tenderness on pressure combined with the other symptoms of nasal fracture.

Roentgenograms always should be taken. They usually will show the location of the fracture and the amount of dislocation of the fragments. At times, however, a fracture in this region will be missed by the roentgen rays. This is because the nasal bones show well on only the lateral view. The postero-anterior view shows them very poorly. Because of this roentgenograms cannot be relied upon as much as in fractures of other bones. If the fracture and displacement do show, a recheck roentgenogram should be taken after the bones have been set.

#### GENERAL MANAGEMENT

From a medicolegal standpoint, it is well to establish the presence or absence of external nasal deformity, nasal obstruction and the condition of the sense of smell prior to the injury.

If the trauma is sustained in an automobile injury or on a farm, the advisability of administering tetanus antitoxin must not be overlooked.

It must be remembered that a satisfactory reduction cannot be obtained without anesthesia. The injection of novocaine along each nasolabial fold, plus intranasal packs of cocaine and adrenalin, usually will suffice except for children or hypersensitive adults. In such cases, one of the general anesthetics should be given.

The skin is cleansed thoroughly with soap and water and all dirt and foreign bodies are removed. Any effective present-day germicide may be used. Debridement should be conservative in respect to viable bone, cartilage or skin. Small fragments of bone never should be removed, as they seldom sequester and greatly aid the healing process. Lacerations should be sutured meticulously, subcuticular suturing being preferred.

Repositioning of the fragments is a simple matter of applied mechanics. Deviations of the entire nasal bridge or lateral spreading of the nasal bones can be corrected by external pressure with the thumbs. Depressions of the nasal bones may be elevated with almost any blunt instrument that can be inserted into the nostril. A nasal elevator is preferable. A slight degree of overcorrection must be maintained to allow for a tendency to recurrence. In depressed fractures, a quarter inch vaseline gauze pack forced upward between the septum and lateral wall on either or both sides will stabilize the fragments. This packing may remain a day or two, after which it is removed or replaced. Occasionally the fragments will be impacted sufficiently to remain in proper position.

In lateral deviations and outward displacements some type of external splint is needed for stabilization. A bandage roll held against either side of the nose by adhesive tape, or a splint molded from dental compound, plaster of Paris or soft metal is satisfactory. For difficult lateral

deviations, a head band appliance may be necessary to exert sufficient lateral pressure.

If the lateral cartilages have been torn loose from the lower margins of the nasal bones or the maxillae, they must be replaced. If a deformity of the septum is present, it will improve greatly following elevation of the depressed nasal bridge. The gauze packing used for maintaining elevation of the nasal bones also will aid in maintaining the septum in the midline, but septal fractures are difficult to maintain in proper position as the cartilaginous septum unites only by fibrous union. If a deformity of the septum does persist, it can be corrected later by a submucous resection.

Fair union begins in about one week, while firm union may be expected in three to four weeks. The older the deformity, after the first four or five days, the more difficult it is to correct, and the greater is the force necessary to separate the fibro-osseous union. The skin dressings are continued for as long as necessary.

#### COMPLICATIONS

Infection of the external or internal wounds may produce abscesses. Softening or necrosis of bone or cartilage may develop following hematoma or abscess. This may produce secondary deformities resulting

from the contraction of the tissues. The most marked example of these is the saddle-back nose. Emphysema may be noticed if the fracture opens into the nasal cavity. The lacrimal duct may be obstructed if the nasal processes of the maxillae are involved. The nasal bone may be forced up into the floor of the anterior fossa of the skull and intracranial complications may arise. Osteomyelitis, chondritis, erysipelas, cellulitis, periostitis or perichondritis may be late complications.

#### SUMMARY

The importance of careful attention to all injuries in the middle third of the face is obvious since fractures can readily be disguised by edema of the soft tissues.

Improper treatment may result in the development of unsightly deformities which will impose a mental, social and economic handicap on the patient.

Painstaking repositioning of fragments is necessary and slight overcorrection of the deformity is required to obtain a satisfactory end result. Some form of immobilization must be employed in many instances to prevent a recurrence of the deformity.

Each case should have a detailed analysis of individual structures and not just a diagnosis of fracture of the nose.



# SEBACEOUS, MUCOUS, DERMOID AND EPIDERMOID CYSTS\*

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COMPARED to many types of neoplasms affecting the body, sebaceous, epidermoid, inclusion dermoid and mucous cysts are relatively unimportant. However, since the majority of such tumors occur about the head and neck where they are unsightly or at least conspicuous, there is always a demand for the removal of such growths by surgical procedures which leave a minimal amount of residual scarring. While some individuals apparently are unconcerned over such tumors unless they are associated with an active inflammatory process, there is an increasing number of people who seek medical advice about such growths because of the fear that they may be of a malignant nature. Aside from the patient's viewpoint, the removal of all such cysts is to be recommended because many are likely to become acutely infected and suppurate for a lengthy period of time and because in rare instances one will undergo a malignant change.

Mucous cysts, which are lined with cuboidal or columnar epithelium and contain a mucoïd material, offer no diagnostic uncertainties on microscopic examination. However, many cysts of the sebaceous, epidermoid and dermoid varieties are difficult to distinguish because their histologic structure may be very similar and because there is no uniformity among pathologists as to the exact characteristics of these tumors. Broders and Wilson have found that practically all so-called sebaceous cysts which are lined with stratified squamous epithelium do not contain the fatty, sebaceous and odorous material typical of a sebaceous gland but contain layer upon layer of nonfatty, odorless (unless infected) keratin. They, therefore,

prefer to call these keratin filled tumors "keratomas." (Fig. 1.) A true inclusion dermoid cyst, which develops along the embryonic clefts and lines of fusion, is lined with stratified epithelium which possesses sebaceous and sweat glands and hair follicles; the cheesy material in such a growth is of a sebaceous character. In the stratified epithelial lining membrane of an epidermoid cyst, no hair follicles or sebaceous or sweat glands are evident although the cystic contents are sebaceous in nature. The majority of epidermoid cysts are congenital and develop in situations corresponding with those of inclusion dermoids. The former, therefore, are probably inclusion dermoid cysts rather than sebaceous cysts; certainly, they are not keratomas. Confusion is added to this conception of epidermoid cysts since many pathologists consider all sebaceous cysts and keratomas as epidermoid tumors. For the sake of clarity I prefer to recognize those cystic skin tumors whose contents consist of keratin as "keratomas," and those which are of acquired origin and which contain sebaceous material as "sebaceous cysts." I consider "inclusion dermoids" to be congenital cysts developing along the embryonic lines of fusion and containing hair follicles and sweat and sebaceous glands in their walls. "Epidermoids" are similar in nature to dermoid cysts with the exception that their linings possess none of the previously mentioned dermal structures.

Although keratomas and sebaceous cysts may arise in the subcutaneous tissues of any part of the body, the majority occur in the scalp and in the lobe and on the posterior surface of the ear. In these regions they are frequently multiple. Such tumors

\* From the Section on Laryngology, Oral and Plastic Surgery, Mayo Clinic, Rochester, Minnesota.

are usually rounded, firm, and though freely moveable are invariably attached to the skin at one point, a feature which

tirely to trauma as would occur from squeezing or from a blow. If such be the case, no pus is produced, and within the

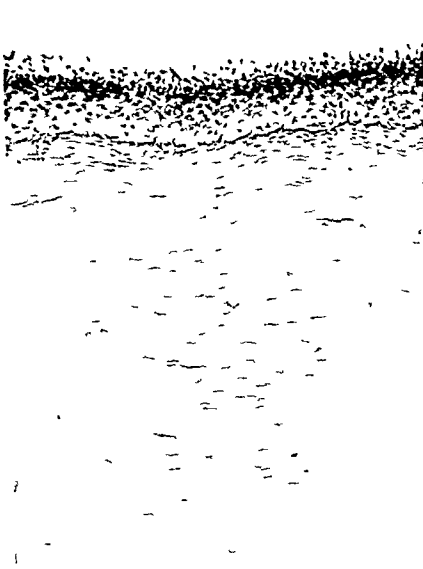


FIG. 1. Keratoma; the lining membrane of stratified squamous epithelium is apparent as well as the countless layers of keratin within the cavity of the cyst ( $\times 130$ ).



FIG. 2. Keratoma containing a grade 1 squamous cell epithelioma; the penetration of malignant tissue into the keratin content of the cyst is visible ( $\times 130$ ).

often distinguishes them from dermoid and epidermoid cysts. In the skin overlying many keratomas and sebaceous cysts, there is visible an enlarged pore from which cheesy material can be expressed on manipulation of the growth. There is a wide degree of variability in the dimensions of these tumors; some are minute, scarcely visible nodules, while others attain a diameter of several centimeters. Inconstant also is the thickness of their walls, which is largely dependent upon the width of the fibrous capsule surrounding them. Those situated in the scalp are usually heavily encapsulated, while those about the face and ears often possess an extremely thin fibrous covering.

Keratomas and sebaceous cysts, ordinarily symptomless, are frequently the site of an acute inflammatory process in which the tumor becomes excessively tender and painful, and objectively suffers a sudden increase in size. Such an inflammatory condition may not necessarily be the result of bacterial invasion but may be due en-

course of a few days the inflammatory process undergoes complete resolution. More commonly, however, bacterial infection is the etiologic basis for the inflammation. Much purulent material is then formed within the cavity of the cyst, which eventually ruptures and discharges its contents. When acutely infected, the cyst resembles an acute abscess and exhibits all of the general and local symptoms which attend such a process. Following an acute infection, a keratoma or sebaceous cyst may resume its normal proportions and appearance. Occasionally, the infection completely destroys the epithelial lining and with subsequent healing the entire cavity of the growth is obliterated. Under such circumstances, the tumor disappears altogether and is replaced by scar tissue. Unfortunately, an acute infection in one of these tumors often becomes chronic. The causative organisms remain in the walls of the cysts and incite the production of purulent material which is continually discharged externally through a sinus.

Such suppuration, when long continued, produces marked excoriation of the surrounding skin. Naturally, acute exacer-

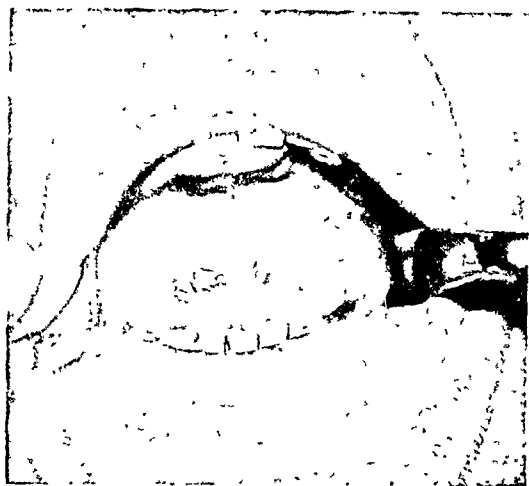


FIG. 3. Large dermoid cyst of the floor of the mouth, pushing the tongue up to the palate and producing much interference with articulation, mastication and deglutition.

bations of chronic infection are common. When chronically infected, a sebaceous cyst or keratoma becomes surrounded by dense fibrociatricial tissue which may completely mask the true nature of the lesion.

Much care should be exercised in removing keratomas and sebaceous cysts. If, while extirpating such a tumor, a remnant of its lining is left within the wound, the growth will promptly recur. Consequently, the old method of transfixing a sebaceous cyst, expelling its contents, and pulling away its lining membrane is usually unsatisfactory especially when the cyst is not heavily encapsulated. By such a procedure, a thin-walled cyst tears readily and its complete removal is seldom accomplished.

It is preferable to excise a keratoma or sebaceous cyst through a skin incision, which should be made cautiously to avoid nicking the wall of the underlying cyst. Moreover, when the growth is situated on the face, the direction of the line of incision should follow the normal furrows of the skin, which greatly decreases the conspicuousness of the ultimate scar. After incising the skin, two small hooks employed to retract the cut edges give an excellent

exposure of the top surface of the tumor. Then, by careful blunt dissection, using a curved forceps or dissecting scissors, the entire growth can be shelled out intact. Although painstaking, this technic rarely results in tearing of the wall of the cyst and assures its complete removal. Should there be present a sinus or pore from which the contents of the growth can be expressed, it is well to include a segment of skin surrounding this sinus in the initial incision. Havens has described a method of injecting procaine hydrochloride for local anesthesia between the skin and wall of the cyst which renders the line of cleavage edematous and, in turn, facilitates dissection. He said that "the needle [of the syringe] is inserted at a point near the apex of the tumor (near the base if the skin over the apex is very thin) with the bevel of the needle turned toward the tumor and its shaft nearly parallel to the surface of the skin. It should be inserted slowly and at the same time a little pressure should be applied to the plunger of the syringe. The aim is to advance the needle only until its tip is just under the skin. Usually, it is easy to tell when this point has been reached by the lessened resistance to the progress of the needle and also by the fact that the solution readily enters the tissues. When properly inserted, the tip of the needle is in the line of cleavage between the capsule of the cyst and the surrounding tissues. The solution when injected at this point follows the line of cleavage completely around the tumor and usually provides perfect anesthesia."

Small, extremely thin-walled cysts which occur commonly about the ears and face are often difficult to eradicate by the foregoing method of dissection. In these cases, removal is simplified by sharply excising a block of tissue surrounding and including the cyst.

Following excision of a keratoma or sebaceous cyst, the skin edges should be approximated and neatly sutured with a fine suture material. Of more importance, however, is the care of the cavity created by removal of the tumor. Blood and serum

should be prevented from collecting in such a cavity by establishing complete hemostasis and by attempting to collapse its walls. Obliteration of the cavity may be effected by means of subcutaneous catgut sutures in small wounds and by the use of an external pressure dressing in those of large dimensions. Such care is particularly important after the dissection of a large cyst in the anterior part of the scalp. Should a hematoma develop here, it is likely to migrate downward infiltrating the tissues of the forehead and eyelids, a serious complication if the hematoma becomes infected. In addition to pressure over large wounds, it is advisable to insert a drain for forty-eight hours; rubber bands make most effective drains and leave an insignificant opening on removal.

Excision of these tumors when acutely inflamed is strictly contraindicated. However, under local anesthesia produced by a spray of ethyl chloride they may be incised and their contents expelled. This relieves the local symptoms and hastens resolution of the inflammatory process. As previously stated, an acute infection in one of these cysts may completely destroy its lining; healing of the wound may follow with permanent disappearance of the growth. But in the event that the cyst recurs, excision should be postponed until three or four weeks have elapsed following the active inflammatory process.

Chronically infected cysts become surrounded by such a dense layer of fibro-cicatricial tissue that any line of cleavage which may have been present about the tumor is entirely destroyed. Consequently, their removal necessitates sharp dissection followed by ample drainage of the wound. If the cyst is situated on the cheek, sharp dissection should be undertaken with much caution for fear of injuring some of the fibers of the facial nerve or perhaps even the parotid duct. Particularly troublesome are chronically infected cysts on the posterior surface of the neck; even after their complete excision, chronic suppuration from the dense scar tissue of the wound may

persist. In such cases, in preference to excision, therapy should consist of exposure of the cystic cavity followed by



FIG. 4. Inclusion dermoid cyst of the bridge of the nose with an external sinus. This growth had been noticed since the patient's birth, was attached to the underlying periosteum, and possessed a tract of dermoid tissue extending between the nasal bones. Removal was effected by excision of the tumor together with the attached periosteum. The deep sinus tract was destroyed with surgical diathermy.

thorough destruction of its lining and the surrounding tissues with surgical diathermy. The wound should then be packed widely open with iodoform gauze until healed.

One cannot sufficiently emphasize the importance of examining microscopically every keratoma and sebaceous cyst which is removed. Although of rare occurrence, malignant changes definitely do develop in the epithelial lining of these tumors. At the Mayo Clinic, we have encountered several squamous cell epitheliomas in keratomas. (Fig. 2.) In one instance, I removed such a growth which revealed histologically a grade 2 squamous cell epithelioma which had perforated the capsule of the cyst; in this case, it was necessary to electrocoagulate the operative site thoroughly after operation. Sebaceous cysts developing in basal cell epitheliomas are not to be

confused with malignant changes in a keratoma or sebaceous cyst.

A mucous cyst represents a true retention cyst in which the orifice of a mucous gland becomes obstructed, forcing the mucus subsequently secreted to accumulate within the lumen of the gland. Mucous cysts are most frequently encountered about the lips and within the mouth. Frequently, they discharge their contents spontaneously, and this process is followed by refilling of the cyst with mucus. As in the case of keratomas and sebaceous cysts, mucous cysts may become acutely infected. The removal of mucous cysts by excision is comparatively simple unless they are situated in inaccessible recesses of the oral cavity. Under such circumstances, they can be easily destroyed with surgical diathermy.

Inclusion dermoids and epidermoids are simple, congenital cysts, which develop along the lines of embryonic fusion as the midventral and middorsal lines and the branchial clefts. Inclusion dermoids are not to be confused with congenital dermoid cysts of teratoma type, which arise from embryonic germinal epithelium. Occurring usually in the ovaries and testes, teratoma dermoids possess a thick wall which contains elements derived from any one or all three of the germinal layers. Well-developed structures such as nails, teeth, brain and glandular tissues are frequently encountered in these cystic teratomas. Acquired implantation dermoid cysts also are to be distinguished from congenital inclusion dermoids. The former type represents merely an inclusion cyst that develops as a result of trauma; a portion of skin is carried into the deeper structures of the wound where the dermal cells form a cyst lined with squamous epithelium. Implantation cysts occur most commonly on the hands but occasionally on other exposed parts of the body.

Practically all inclusion dermoid cysts are found about the head and neck. On analysis by New and the writer of 103

dermoids of the head and neck, 49.5 per cent involved the orbital regions and eyelids, 23.3 per cent of the floor of the mouth, 12.6 per cent the nose and 14.6 per cent the median line of the lips and median line of the occipital, frontal and cervical regions. Dermoid cysts are prone to develop in these locations because they are the fusion sites of various embryonic structures. Moreover, it is not surprising that a greater percentage of these cysts occurs in the orbital region than elsewhere when one considers the complexity of the embryonic development of the eyes and lids.

Inclusion dermoid cysts, which may vary in size from a few millimeters to several centimeters, are rounded growths, situated in the subcutaneous tissues and are but rarely attached to the overlying skin. Their congenital nature is evidenced by the fact that a large percentage of these tumors are apparent at or shortly after birth. While the smaller ones are usually firm, those of larger dimensions have a characteristic doughy feeling. In a few, a sense of fluctuation can be elicited. Many of these growths possess a sinus from which sebaceous material can be expressed and from which hairs may be found to protrude. On removing many dermoid cysts, especially those about the orbits and frontal region, a crater-like depression in the underlying bone is found. In an occasional case, cord-like extensions into the surrounding soft and bony tissues are discovered. Inclusion dermoid cysts may be distinguished from keratomas and sebaceous cysts by their situation, their congenital nature and by the fact that they are seldom attached to the overlying skin. These characteristics are suggestive; a doughy feeling is characteristic, and the protrusion of hairs from a sinus of the cyst is diagnostic of a dermoid.

Dermoid cysts involving the floor of the mouth, submental or submaxillary regions, may be, when small, palpable but symptomless. However, they have a marked tendency to increase ultimately in size either in the course of their natural growth or

through infection. When reaching large proportions, they often push the tongue up against the palate, causing difficulty in articulation, mastication and deglutition. (Fig. 3.) Fortunately, dysphagia and dyspnea are rarely encountered, but when present are at times serious. Since the treatment of dermoids involving the floor of the mouth, submental and submaxillary regions certainly does not come within the realm of office surgery, methods for their removal will not be discussed in this paper.

Dermoid and epidermoid cysts in other sites may be excised in a manner similar to that described for keratomas and sebaceous cysts. However, dermoids are inclined to be fixed to the surrounding tissues which makes their removal by blunt dissection often impossible. On the contrary, sharp excision is frequently essential. When an external sinus is present, the initial incision should include an elliptic portion of skin around the sinus, which facilitates removal of the tract. It is important to bear in mind that cord-like extensions from any dermoid cyst may be present; these should be dissected away from the adjacent tissues if a cure is to be expected. When adherent to

bone, the periosteal attachment must be removed along with the tumor.

In many dermoid cysts involving the bridge of the nose (Fig. 4), extirpation is met with difficulties inasmuch as such growths not only are frequently attached securely to the underlying periosteum but also may possess a sinus tract of dermoid tissue that extends down between the nasal bones into the septum. If one removes the surrounding bone in an attempt to excise such a tract, the procedure may result in considerable deformity of the nose. When excision is inadvisable, the tract often may be removed by light electrocoagulation with surgical diathermy, a current of insufficient strength to cause sequestration of the adjacent bone being employed.

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# EMERGENCY TREATMENT OF HEAD INJURIES IN THE ACCIDENT DISPENSARY\*

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THE increase in head injuries caused by automobile accidents has placed a definite responsibility upon the shoulders of the intern in the accident dispensary. He sees the patients when they are at their worst. They are often in shock and the cerebral symptoms are complicated and masked by injuries elsewhere or by alcoholism. The intern's judgment and treatment frequently decide the fate of the individual. If careless, he may permit the premature discharge of a subdural or epidural hemorrhage suspect. Broken bones, especially fractures of the spine and internal injuries, may be missed in the unconscious patient if they are not thought of and looked for. The stuporous patient having an alcoholic odor may be erroneously labeled "another drunk" and so indicted on the chart from a medical and legal sense, when he may actually have a skull fracture and perhaps may have had only an innocuous glass of beer.

In a teaching institution or a hospital where a resident staff is present, the intern has the advantage of an immediate consultation with the residents in the various specialties if problems in diagnosis or treatment occur. However, in the majority of hospitals in this country the intern must handle the emergency himself, at least for the first hour or two until his chief arrives.

The following plan of emergency treatment of head injuries is taught by Professor Temple Fay and associates to the senior students of Temple University School of Medicine and is followed by the interns on duty in the accident dispensary of the hospital. In addition, the intern is required to fill in a brief but pertinent form which is a valuable record for the intern who

receives the case. This form becomes part of the hospital record or the dispensary record if the patient is not admitted.

## OUTLINE FOR EMERGENCY TREATMENT OF HEAD INJURIES IN THE ACCIDENT DISPENSARY

### A. *Treat Shock First.*

1. Patient flat. Do not lower head.
2. *Apply heat* until rectal temperature is 99 degrees or above. *Careful of burns.*
3. If hemorrhage from scalp wound is present, control it temporarily by packing wound with *dichloramine "T" 1 per cent or alcohol pack* and *fairly tight bandage*. Arterial bleeding is controlled by hemostats and the vessels ligated *after patient reacts from shock.*
4. Give adults 50 cc. of 50 per cent glucose intravenously stat.

Children are given one-half to one-third this dose. If volume of pulse is poor and rate is 120 or over and there is no marked improvement within 10 minutes after glucose injection, give *normal saline slowly intravenously* (60 drops per minute and about eight ounces or 240 cc. every hour) until pulse rate drops below 120 and systolic blood pressure rises to 90 or above and diastolic pressure to above 60. May repeat glucose in one-half hour if no improvement.

5. If excessive perspiration is present, prevent further depletion of blood volume by subcutaneous in-

\* From Temple University School of Medicine.

jection of 15 minims of surgical pituitrin every one-half hour and atropine sulfate gr.  $\frac{1}{100}$  subcutaneously every hour until blood pressure has reached level as given above in (4).

6. If loss of blood is excessive, have patient and available donors typed and crossed while infusion is given and *transfuse if necessary*.

7. Make sure that patient has an *adequate airway*, that the tongue does not fall back and that no foreign bodies or dental plates are left in the mouth. Be careful when applying metal mouth gags. A broken or loosened tooth may be aspirated into the lungs.

8. If the patient is unconscious, 10 per cent carbon dioxide in 90 per cent oxygen may be given intranasally by two small catheters attached to a glass "Y" tube.

*B. While above Treatment Is Progressing, Examine Patient for*

1. Fractured bones (suspect a fracture of spine, especially in cervical region until proven otherwise).

2. Injury to ribs (subcutaneous emphysema, hemo- and pneumothorax).

3. Abdominal, renal and pelvic injury or hemorrhage.

4. *Do not move or turn patient during shock.*

(a) If long bone is fractured, apply temporary splint without manipulation. If compounded, call resident or chief.

(b) If chest, abdominal or pelvic injury is suspected, call resident or chief immediately.

(c) If cervical fracture is suspected, support head and neck with sand bags on either side. Call resident or chief.

*C. When Patient Reacts from Shock* (usually 15 minutes to one hour after onset of treatment). Rectal temperature rises to 99 degrees or above;

systolic pressure to 90 or above, and diastolic to 60 or above.

1. *Do a careful neurologic examination:*

(a) Inspect ears, nose, mouth and throat for evidence of bleeding or cerebrospinal leak and the sclera for subconjunctival hemorrhage (basilar fracture?).

(b) Decide whether patient is aphasic or unconscious by strong pressure over supraorbital nerves. If patient endeavors to remove examiner's hands from painful area, he is not unconscious. Facial muscles will grimace on side of painful stimulus if patient is not unconscious.

(c) Note size and shape of pupils and reaction light. A fixed, dilated pupil or a progressively dilating pupil on one side suggests an expanding epidural or subdural clot, fluid or edema on that side.

(d) Examine cranial nerves (see b).

(e) Test patient's ability to use extremities. Check for weakness or paralysis. External rotation of the entire lower extremity when not voluntary is caused by a fracture of the femur or paralysis of the extremity. If patient is unconscious, raise both upper extremities above the head and permit them to drop to bedside. The parietic or paralyzed extremity drops in a flaccid "rag doll" manner.

(f) Test the deep tendon reflexes and for the Hoffman and Babinski sign.

(g) Note the reaction of the patient to painful stimuli applied to each side of the body.

(h) Check patient now for possible fracture of spine. Do

not move patient from table until satisfied that no obvious fracture of spine, especially in cervical region, is present. If cervical fracture is suspected, apply chin-occiput harness with steady traction before moving. If fracture of other vertebrae are suspected, avoid flexion and extension movements in transporting patient. Do not move patient unless you have enough help to lift him properly.

#### D. *If Neurological Examination Shows*

1. Cerebral involvement as evidenced by any of the following: prolonged unconsciousness (one-half hour or more since the accident), aphasia, definite pupillary changes, psychotic or peculiar actions, weakness or paralysis of the extremities, sensory changes, the patient should be admitted and sent directly to room or ward.

2. If patient's general condition is good, laceration, if present, can be sutured in accident dispensary. If it is extensive or condition poor, cleanse, secure hemostasis, pack, delay suturing and admit patient to house (see treatment of laceration).

#### E. *If Patient Has Reacted from Shock, Is Conscious, and Neurologic and Physical Findings Are Negative and There Is Still Doubt as to Cerebral Injury*

1. Do lumbar puncture (see technique and contraindications below). Record pressure and take off 1 to 3 cc. of fluid to determine whether clear or bloody. If spinal fluid is pink or cherry red in color and homogeneous throughout, subarachnoid hemorrhage is present and is evidence of laceration of the pia and a probable skull fracture.\* Patient should be admitted.

2. If spinal fluid is clear and pressure is above 12 mm. of mercury, or 160 mm. of water under correct technic, patient should be admitted to dispensary bed and observed for possible subdural or epidural clot.

3. If spinal fluid is clear and pressure below 12 mm. of mercury, laceration of scalp should be sutured if present. Patient should then be kept in accident ward for observation for at least two hours and then discharged if feeling well, with instructions to report to family physician or if clinic patient to report to accident dispensary if severe headache, vomiting or any unusual symptoms occur. Patient should not be discharged from dispensary unless accompanied by friend, relative or police, who can escort patient home where he can be watched for any untoward symptoms.

#### F. *Method of Examining and Repairing Laceration of Scalp.*

1. Cut and then shave all hair within a radius of at least two inches from any point of the laceration. In a woman so arrange the hair and comb it so that later the uncut part can be combed over the cut area.

2. Cleanse shaved area thoroughly with soap and water, avoiding the laceration or its edges at this stage.

3. Apply three and one-half per cent iodine to cleansed area and remove with alcohol.

4. Put on sterile gloves and completely surround peripheral border of shaved area with a one per cent novocaine block so that the novocaine ring is one inch internal to the hair border. (Fig. 1.)

5. The laceration will now be anesthetic and can be cleaned, inspected and sutured without pain to the patient.

6. Inspect wound for foreign bodies. All dirt and grease should be removed from margins or depth of

\* Routine spinal punctures were done on every patient in over 600 cases of head trauma treated on the Neurological-Neurosurgical service. Seventy-five per cent of patients having bloody spinal fluid subsequently had a proven skull fracture.

wound by cotton applicators soaked in benzine. The laceration is then gently irrigated and sponged with ether followed by three and one-half per cent tincture of iodine. (*Caution:* Protect patient's eyes against irrigating solutions.)

7. Change gloves and proceed to inspect wound for injury to bone, herniations of brain tissue, cerebrospinal leak. Use sterile gloved finger to palpate carefully and gently for depressions. Use no probes (these may introduce infection to deeper levels). If inspection or palpation or both suggest a *compound fracture of the skull*, gently pack laceration with dressing of one per cent dichloramine "T" or alcohol and admit patient to the hospital. Never suture a laceration in a suspected compound fracture of the skull except in an operating room where the set-up will permit handling of any difficulties or complications that may occur when bone fragments are manipulated or the brain exposed.

8. If there is no evidence that the periosteum has been torn and the bone injured or exposed (in other words if there is no compound fracture), the laceration should be sutured with silk or wire. All traumatized and necrotic tissue should be debrided carefully, saving as much normal tissue as possible. Venous and capillary ooze will be controlled by pressure on edges of laceration and when the sutures are tied.

If the galea is cut, this layer should be approximated with interrupted sutures placed about one-fourth to one-half inch apart and tied firmly with just enough pressure to approximate the edges without strangling them. The skin and subcutaneous layer down to the aponeurosis can then be sutured as a separate layer. The sutures should be placed about one-half inch apart, should enter and

emerge from the skin at least one-fourth inch on each side of the lacerated edge. They should be tied

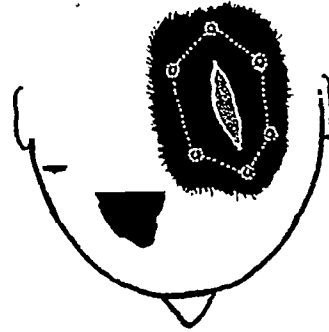


FIG. 1. Preparation of scalp before repair. The scalp is shaved and cleansed with soap and water; followed by application of three and one-half per cent iodine which is removed with alcohol. The laceration is not touched. The wound is then surrounded by a ring of one per cent novocaine which is placed about one inch internal to the periphery of the shaven area. The laceration and its edges are now anesthetic and can be cleansed, inspected and sutured without pain.

just firmly enough to approximate the edges and should lie flat without puckering or creasing the skin.

It is not necessary to drain if the wound has been cleansed thoroughly and appeared clean initially. If the wound was dirty or if a great deal of tissue was contused, insert a rubber dam drain from one-fourth to one-half inch in width in one angle of the laceration before the sutures are tied, so that the inserted end will be under the aponeurotic layer if it was cut, or down to the aponeurosis if only the skin and subcutaneous tissues were involved. The sutures may then be tied.

An alcohol dressing should then be applied to the sutured area and kept in place by a head dressing. (Be

careful not to make head dressing too tight or headache will develop.)

Patient should report in twenty-four hours to family physician or clinic for removal of drain or inspection of wound. Sutures are removed on the fifth day.

9. All dirty or punctured wounds or those received in fields, farms, or about premises where horses or cattle are present, should receive a prophylactic injection of tetanus and gas gangrene antitoxin.

10. Wounds of forehead are treated like those in hair areas except that the deep and subcutaneous layers do not tolerate silk, therefore, No. 000 chromic gut should be used for these deep layers. The skin and subcutaneous layer should be sutured with either interrupted or continuous dural silk and a vaseline gauze dressing applied. No drains are used. The sutures should be removed on the fourth day if healing occurs. These precautions are used to reduce the size of scars.

#### G. *Treatment of Alcoholic with Suspected Head Injury*

1. Treat the same as any head injury case.

2. Do not give depressant drugs.

3. Do not do lumbar puncture and drainage until out of shock.

4. If noisy and uncooperative, patient may be given paraldehyde, drams 1 to 3 by nasal tube.

#### H. *Pointers in Doing Lumbar Puncture*

1. Do not flex head but permit it to be kept in natural position. Flexing head may constrict jugular veins and increase intracerebral venous and hence cerebral spinal fluid pressure as much as 20 mm. Hg. and thus give a false high reading.

2. Never do lumbar puncture in sitting position. Patient to be on his side in horizontal position.

3. Never do lumbar puncture without manometer and initial pressure reading.

#### I. *Contraindications to Lumbar Puncture*

1. Pimples, acne, or infection in or about lumbar puncture area (third or fourth lumbar interspace).

2. Shock.

3. Uncooperative patient.

4. Irregular respirations or (respirations below 16)—suggest medullary compression. Call chief resident or resident on neurosurgery before doing puncture.

If fractured spine is suspected, patient is not to be moved from table until chief resident physician, resident on orthopedics or resident on neurosurgery examines the patient.

#### DISPENSARY RECORDS IN CASES OF HEAD INJURY

Most of the patients have received their injuries in automobile accidents, fights when at work and at times when inebriated. These cases are, therefore, often of medicolegal importance. Accurate records in the dispensary are vital to the patient's interest as well as to others involved and certainly to the intern on the ward who receives the case. Too often the records say "drunk" or under the "influence of alcohol." It is the duty of the intern to record on the records that there is an odor of alcohol if he definitely smells it. He should not state that the person is drunk or under the influence of liquor unless the patient is awake, boisterous, loquacious and exhibits the classical actions seen in the active, acute, alcoholic spree.

Since the intern is extremely busy in the accident dispensary, it is essential that the records he must make be brief and to the point. The following form was arranged and is used in the Temple University Hospital Accident Dispensary:

## TEMPLE UNIVERSITY HOSPITAL

## ACCIDENT DISPENSARY HEAD INJURY RECORD

FILL IN THIS FORM AND SEND WITH PATIENT IF ADMITTED

Name: Color: Age: Sex:

Date: Time: (1) Admitted to dispensary: Brought in by:  
(2) Discharged from dispensary:  
(3) Sent to ward or room:

History: (1) Where found and etiology of accident:

(2) Condition of patient on entering dispensary with initial TPR:

(3) Final TPR and blood pressure when sent to ward or discharged from dispensary:

## Examination:

(1) Location and extent of scalp injury:

(2) Comparative size of pupils and reaction light:

(3) Bleeding or cerebrospinal fluid from cavities of skull:

(4) Abnormal neurologic findings:

(5) List fractures of bones:

(6) List suspected injury to chest, abdomen, kidney, bladder or spine:

(7) List evidence of alcohol odor to breath:

Treatment: Name and amount of drugs and antitoxin given and record of TPR and blood pressure q.  $\frac{1}{2}$  hour:

Lumbar puncture done?

If so, give (a) Initial pressure—  
(b) Amount and color—  
(c) Final pressure—

Record treatment of scalp laceration if present:

Signed:



# INTERNAL DRAINAGE OF THE GALLBLADDER\*

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FOR the past twenty years, whenever practicable, we have used internal gallbladder drainage, that is, turning the infected organ into the stomach or duodenum, as a routine procedure. It is the main object of this paper to report the results of 300 such operations during that twenty-year period.

## GENERAL CONSIDERATIONS

The gallbladder today probably occupies more space in our medical journals than any other single surgical subject. This overwhelming mass of literature, which periodically breaks out like a rash, indicates that, among those who should be authorities, there is little agreement concerning the best time for operation on the inflamed gallbladder; and that the type of operation which best meets the various lesions is far from a settled problem in the surgical mind.

From the mass of often contradictory statements certain points stand out—a dawning realization that gallbladder disease is but a part of a general biliary tract infection involving the whole biliary tree, ducts, liver and frequently the pancreas; that regarding the acute gallbladder opinion is sharply divided as to the advisability of immediate or delayed operation; that in the chronic gallbladder operation is indicated where the organ is acting as a primary pyogenic focus, where there is cholecystic indigestion and colic with x-ray evidence of stones, and where gallbladder symptoms without x-ray evidence of stones are not relieved after three months' medical treatment and duodenal gallbladder drainage; that the

acute case relieved by medical treatment and duodenal gallbladder drainage is not surgical; but that the patient long treated medically, without relief, usually receives prompt benefit from surgery; and that cholecystectomy is today the operation of choice.

## CHOLECYSTECTOMY

*Arguments for Cholecystectomy.* The operation is the complete removal of what, it is hoped, is the etiologic toxic focus. It is a beautiful operation and appeals to the esthetic taste of the skilled surgeon.

*Arguments against Cholecystectomy.* It is a major operation with a relatively high mortality in unskilled hands. Serious postoperative complications may occur. One surgeon reports it as a cause of common duct stricture in seventy-three of eighty cases in which he operated.<sup>1</sup> Removal of the gallbladder does not relieve symptoms in a high percentage of cases. Results published in the 1938 *Year Book of Surgery*,<sup>2</sup> may be quoted as a fair estimate. Following cholecystectomy the mortality given is 7.8 per cent in 5,705 operations, as reported from the personal and collected cases of six authors. Persistent symptoms of biliary indigestion occurred in 52 per cent of 668 cases reported by three authors. Persistent symptoms of biliary colic occurred in 20 per cent of 442 cases reported by two authors. There was a surprising inconsistency in the percentage of cures as reported by different surgeons. Such figures would indicate that cholecystectomy is far from a completely satisfactory operation.

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## CHOLECYSTOSTOMY

*Arguments for Cholecystostomy.* It can be done successfully and has a lower mortality in the hands of the less experienced surgeon. It drains, for a limited time, what may be an infection of the whole biliary tree. It is permanently successful in at least 80 per cent of cases.<sup>1</sup>

*Arguments against Cholecystostomy.* Following external drainage we have a recurrence of cholecystitis or a reformation of gallstones in from 15 to 20 per cent of cases.<sup>1</sup>

INTERNAL DRAINAGE  
CHOLECYSTODUODENOSTOMY  
OR CHOLECYSTOGASTROSTOMY

*Arguments for Internal Drainage.* It maintains continuous drainage of an infected gallbladder or an infected biliary tree. It is a minor intra-abdominal operation with a comparatively low mortality. As a last resort, following unsuccessful cholecystectomy, anastomosis of the common bile duct and duodenum is the accepted surgical procedure.

*Arguments against Internal Drainage.* Animal experiments have demonstrated that following cholecystenterostomy there is an infection of the gallbladder with ascending infection of the biliary tree; and that the fistulous opening closes if the common duct has not been ligated. In the human subject spontaneous rupture of the gallbladder into the stomach or intestinal tract, with formation of a biliary fistula, is frequently followed by symptoms of ascending biliary duct infection.<sup>19</sup>

External gallbladder drainage demonstrates the outstanding facts: that the bile from an infected gallbladder changes from a dirty, tarry or purulent fluid to normal straw colored bile in about four days; that it continues coming through the gallbladder as normal bile as long as drainage is maintained; and that toxic symptoms and colic subside as the bile clears and flows freely. It would seem that if such a flow of normal bile could be continuously maintained through the gall-

bladder into the digestive tract, without reverse infection of the biliary tree or closure of the fistula, the ideal operation is attained.

*Postoperative Cholangitis in Animal Experiments.* Seventy-five cholecystenterostomies done by five operators and reported by three authors<sup>3,4,5</sup> gave results as follows: The dogs were killed from three months to one year after operation. There was laboratory evidence of infection of the gallbladder, bile ducts or liver in all except three dogs. There were no frank liver or bile duct abscesses. No mention was made of the general health of the dogs; presumably it was good. Is it not possible that these low grade microscopic infections in the dog without general health impairment have been given an undue importance in their application to the human subject? And that every individual with a chronic cholecystitis has for years had such a microbic infection of his biliary tree until it acutely localizes in a poorly draining gallbladder? The relief afforded by duodenal tube gallbladder drainage would support the theory.

*Postoperative Cholangitis in Man.* Operators of considerable experience state that in the human subject the danger of liver infection is slight. In 279 cases reported by four authors,<sup>6,7,8,9</sup> there was but one case of suppurative cholangitis. In this case the operation was done for obstructive jaundice from carcinoma of the pancreas. I have collected six cases of death from cholangitis, including one unreported case of my own, which may be summarized as follows:

1. Obstructive jaundice, carcinoma of the pancreas.  
Death three months postoperative.<sup>3</sup>
2. Obstructive jaundice, carcinoma of the pancreas.  
Death seven months postoperative.<sup>8</sup>
3. Obstructive jaundice, chronic pancreatitis.  
Death four months later.<sup>10</sup>
4. Obstructive jaundice, carcinoma of the pancreas.  
Death nine months later.<sup>10</sup>



5. Gallbladder colic for twelve years. Operations during this period were: cholecystostomy, cholecystectomy, choledochoduodenostomy and finally end-to-end suture of the common duct. Patient died twenty-four hours after the last operation of acute cardiac dilatation. Autopsy showed general systemic atheroma with chronic hepatitis.<sup>11</sup>

6. Author's case: The initial operation was a cholecystoduodenostomy for stones. No stone was palpable in the common duct. The patient was in good health and symptom-free for three years. She had intermittent gall stone colic with fever and jaundice for six months before the second operation. The stools were normal in color during the jaundice attacks. At the second operation (Dr. W. W. Babcock) a stone was found in the common duct surrounded by putrid pus. The liver showed tawny areas suggestive of fatty degeneration. The duodenal stoma was open.

Cholecystectomy was done, with closure of the anastomosis and common duct drainage. Postoperatively, hemorrhage, fecal fistula, subphrenic abscess, and empyema occurred, death resulting from general septicemia seven weeks after operation. No autopsy was permitted.

Summarizing the six cases, the first four followed the usual course of common duct obstruction from pancreatic tumor with or without operation. Cholangitis has more frequently developed spontaneously in duct obstruction from tumor of the head of the pancreas than following a planned cholecystenterostomy.<sup>3,7,12</sup> The fifth case, one of chronic hepatitis following anastomosis of the common duct to the duodenum appears to have been one of a general body sclerosis. The author's case was a true suppurative cholangitis apparently due to unrecognized common duct stone at the time of the original operation. It is possible that removal of this stone with bile duct drainage might have averted the ultimate catastrophe. These six cases indicate that symptomatic cholangitis following routine internal gallbladder drainage is very rare.

*Closure of the Biliary Fistula in Animal Experiments.* The report of three research workers<sup>4,13,14</sup> on dogs, is that if the common duct is not ligated, the flow of bile is not

diverted from the common duct and the biliary fistula tends to close. But one must remember that in dogs we have a presumably healthy biliary tract, not the infected biliary tree of the human subject who presents himself for a gallbladder operation.

*Closure of the Biliary Fistula in the Human Subject.* I have not found recorded any evidence of secondary abdominal operation where a previously made biliary fistula was examined. It is my privilege to report findings in eight cases, seven of which I personally explored during the past nineteen years.

CASE I. Cholecystoduodenostomy was done in a female, 24 years old, who had a strawberry gallbladder. She had no biliary symptoms for two months. Posterior gastroenterostomy was done eight months later for a gastric ulcer. The patient is living and has no biliary symptoms nineteen years later.

CASE II. Cholecystoduodenostomy was done in a female, 44 years old because of gallstones. Operation four years later for an incarcerated hernia in an old low abdominal scar showed a prolapsed leather bottle stomach. Death occurred from progressive asthenia three weeks later.

CASE III. Cholecystoduodenostomy in a female of 42 was followed four years later by operation for pyloric obstruction from a thickened contracted pyloric muscle. Posterior gastroenterostomy was done. Death occurred from myocarditis three years later.

CASE IV. Cholecystogastrostomy was carried out in a 48 year old female who had cholecystitis with jaundice. Exploratory operation five years later for intermittent hiccough showed adhesions with angulation of the transverse colon to the scar. The adhesions were freed and no recurrence of jaundice took place during fifteen years. The hiccough recurs, but this is probably psychic.

CASE V. Cholecystoduodenostomy in a female, 45 years old, for gallstones, was followed four and one-half years later by operation for recurrent epigastric distress and a large keloid in the abdominal scar. No intra-abdominal pathology was found. The patient died of peritonitis seven days later. Autopsy showed no cause for the peritonitis. There was no leakage or sign of infection about the exploratory incision in the gallbladder.

CASE VI. Cholecystogastrostomy was done in a female, 50 years old, who had gallstones. A second operation was done three years later for an obstructive band at the ileocecal region. Two years later the patient was living, and had no gallbladder symptoms.

CASE VII. Cholecystogastrostomy for cholelithiasis in a female, 61 years old, was followed by exploratory operation three and one-half years later for an inoperable cancer of the descending colon.

CASE VIII. Same as the fifth case mentioned under postoperative cholangitis.<sup>11</sup> Here a functional patulous fistula was noted.

The exploratory findings about the anastomosis were practically identical in the first seven cases. The adhesions in all except Case VIII were not marked nor comparable in density to many I have remarked in opening the abdomen following a cholecystectomy. The gallbladder in each case was contracted, with its surface vascularized, and looked more like intestine than gallbladder. It was from  $\frac{3}{8}$  to  $\frac{1}{2}$  inch in diameter, and its walls averaged  $\frac{1}{8}$  inch in thickness. The mucosa was soft. Inside was a patulous duct, about  $\frac{1}{4}$  inch in diameter, slightly contracted at the fistulous opening. A grooved director could be freely passed into the cystic duct and into the duodenum or stomach. It contained straw-colored liver bile. The liver, by inspection, showed no evidence of hepatitis.

The results in these eight cases indicate that, in the human subject with an infected biliary tree, the fistula does not close if the common duct is not ligated, and the gallbladder resolves itself into an accessory functional bile duct carrying healthy bile.

#### CHOLECYSTODUODENOSTOMY OR CHOLECYSTOGASTROSTOMY

*From the Standpoint of Infection.* Bacteriologists state that the intestinal bacteria increase from the duodenum down to the sigmoid, and that the colon bacillus is the chief offender in biliary tract infections. The colon bacillus is less common in the duodenum and stomach than in the distal digestive tube. The general bacterial

count is higher in the stomach than in the duodenum, but colon bacilli and streptococci are uncommon in the stomach and frequent in the duodenum. The gastric juice exerts a destructive influence on bacteria.<sup>17</sup>

*From the Standpoint of Surgical Technique.* Because of its mobility and the thickness of its walls, stomach anastomosis is more easily done and is apt to give a less permeable suture line. Bile in the stomach does not disturb gastric processes.<sup>18</sup> Most operators have preferred the duodenum as it most nearly restores normal physiologic relations. However, the duodenum must frequently be mobilized before an anastomosis without tension can be made and every extra intra-abdominal incision adds to the danger of infection in an already contaminated area. Our last series of 100 cases, without mortality, have all been stomach anastomoses. We have come to feel that the stomach fistula is preferable because it is an easier operation, is less traumatic, and bacterial studies indicate that there should be less danger of retrograde infection.

#### OPERATIVE TECHNIQUE

Open the abdomen under combined spinal and local anesthesia. When necessary, free the distal end of the gallbladder from the under surface of the liver sufficiently to allow the fundus to lie against the point of anastomosis without tension or kinking. Do a classical end-to-side anastomosis with a stoma  $\frac{1}{2}$  to  $\frac{3}{4}$  inch long. (Fig. 1.) With a distended gallbladder the anastomosis can often be done without liver separation. This is the ideal operation as it opens fewer portals for infection. A small cigarette safety drain is left in place for forty-eight hours.

#### STATISTICS

In two previous articles I have reported results in 200 cholecystenterostomies.<sup>13,14</sup> I now add another 100 cases done during the past nine years.

In the whole group of 300 cases, all of which had combined spinal and local anesthesia, 130 were duodenal anastomoses

follows the accepted principle of abscess drainage in other body areas. A secondary cholecystogastrostomy was done in four

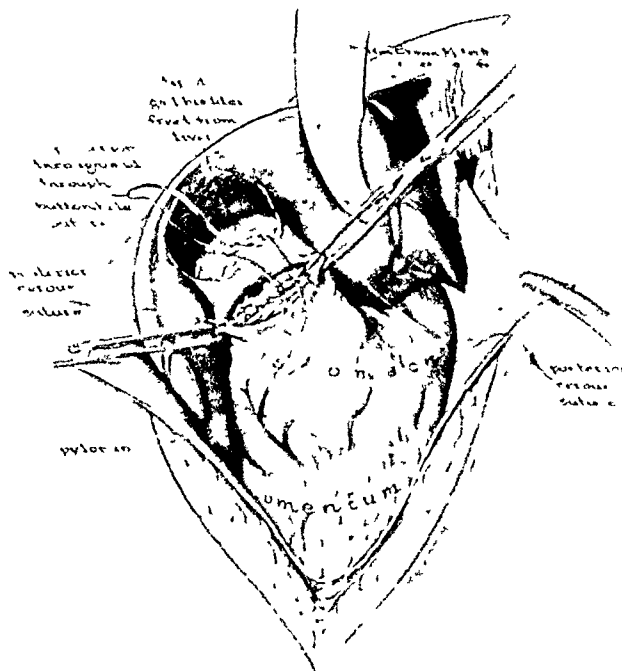


FIG. 1. Technic of cholecystogastrostomy. The gallbladder is mobilized by partial freeing from its liver attachment. A typical end into side anastomosis is made by a fine linen serous stitch and No. 00 chromic gut through and through buttonhole stitch. In the distended gallbladder, freeing from the under surface of the liver is unnecessary.

and 170 stomach anastomoses. In 66 per cent stones were present. Of the group, 88 per cent were women, and the average age was 45 years, with the youngest 18 and the oldest, 72. The total postoperative mortality was 3 per cent. Causes of death were: epidemic flu, one; one following administration of intravenous glucose (before the day of proper glucose standardization); four deaths, 1.33 per cent, the direct result of the operation.

In the last 100 cases, all were cholecystogastrostomies and there was no postoperative mortality. This flattering result was probably due to more careful preoperative and postoperative care in which rest, intravenous glucose guarded by insulin, and saline hypodermoclysis were the main factors. In the bad risk or where suppuration or extensive gangrene existed, a simple cholecystostomy was done. This

cases in this series where symptoms of cholecystic indigestion recurred after spontaneous closure of the external fistula. All four were relieved following the second operation.

*Follow-up in 100 Consecutive Cases.* Operation in this group was done from three to twenty years ago, and records were obtained from patients or their families. They were questioned in regard to recurrent jaundice, gallstone colic or cholecystic indigestion.

Recurrent jaundice occurred in but one case (mentioned under "postoperative cholangitis"). A common duct stone produced symptoms three years after operation.

True gallstone colic occurred in the one case just mentioned. Three others gave an identical history of symptomatic stone: pain without jaundice, lasting from one-half to three hours, occurring three or four

times each year and ceasing suddenly without medication. One can visualize in these cases a contracted stoma and an

dile aged subjects have some gas and complain of it. We accept the definition of cholecystic indigestion as a qualitative

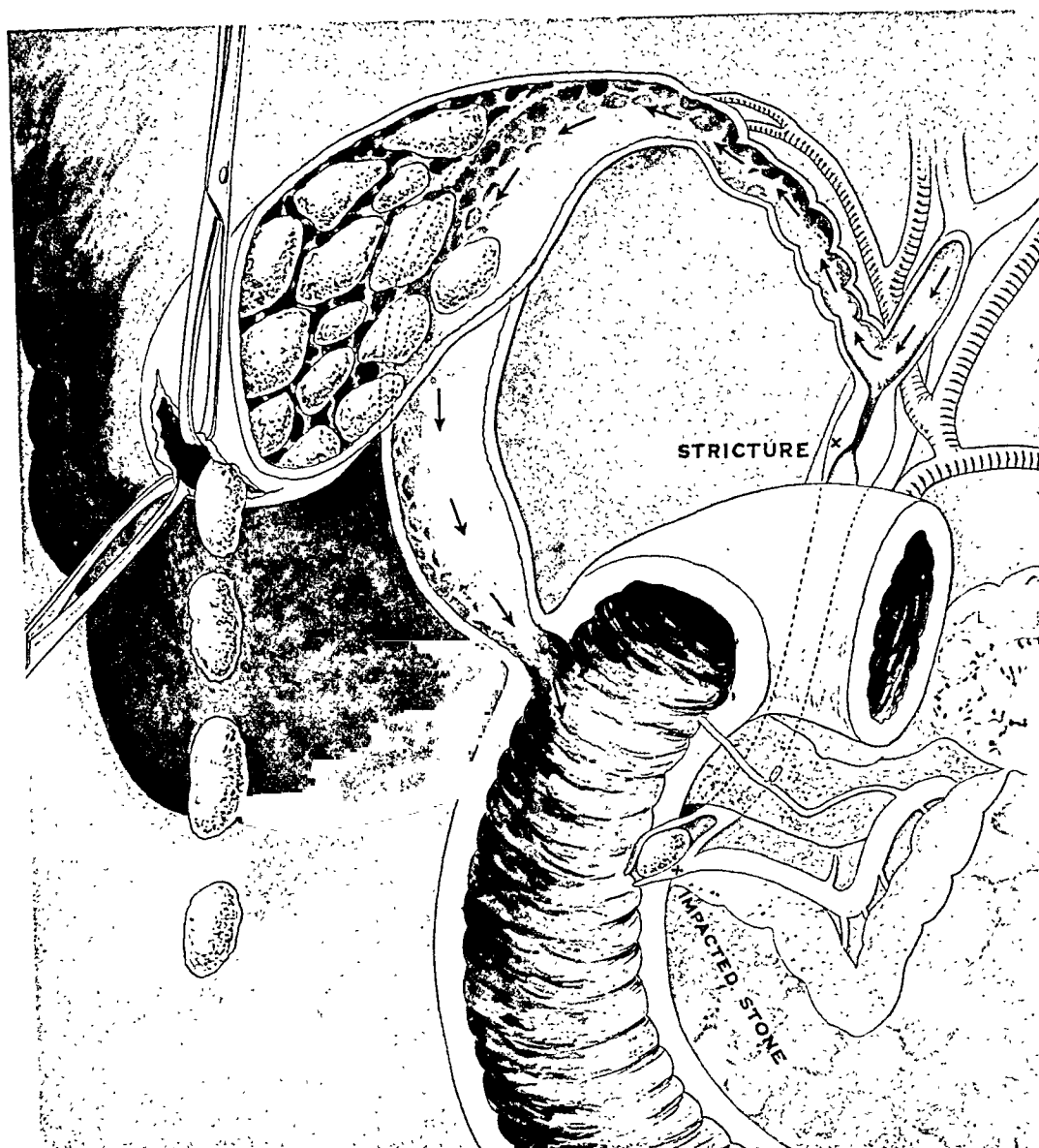


FIG. 2. Schematic cholecystoduodenostomy. Gallbladder opened; contents evacuated; fundus anastomosed to duodenum opposite papilla of Vater. The continuous flow of bile through the gallbladder prevents stone reformation and drains the whole biliary tree. The gallbladder acts as an accessory bile duct in obstruction of the common duct from stricture, neoplasm or impacted stone. (From Steel, in *Pennsylvania M. J.*, October, 1930.)

acutely distending gallbladder, with sudden relief as the dilating bladder forced open the stoma and the bile again escaped through the safety valve into the digestive tube.

Cholecystic indigestion was a difficult point to decide honestly. In this day of overeating and under-exercising, most mid-

dyspepsia, with fullness after eating and distress in the epigastrium or under the ensiform, accompanied by sour, bitter eructations, belching and occasional vomiting. In this series fifty-four patients claimed perfect digestion after normal eating. Thirty had some symptoms, less severe than before operation, and were

satisfied. Ten had typical symptoms every time they indulged in forbidden foods, and six claimed no relief. This would give about 84 per cent of permanent relief.

### CONCLUSIONS

1. A cholecystitis may be merely part of a general biliary tract infection involving ducts, liver and frequently the pancreas.

2. Such an infection requires drainage, as evidenced by the temporary relief of symptoms, following duodenal tube drainage or by the operation of cholecystostomy.

3. Cholecystectomy, while it permanently removes the infected gallbladder, leaves the remainder of an infected biliary tree undrained. This probably accounts for the persistent biliary symptoms in 50 per cent of cases following cholecystectomy.

4. Cholecystenterostomy cleans out the infected gallbladder and gives a continuous drainage of the biliary tree and should be an ideal operation.

5. Cholecystenterostomy has not met with general surgical approval since research workers on healthy dogs reported that ascending bile duct infection followed, and that the biliary fistula closed if the common duct was not ligated.

6. We have produced evidence pointing to the facts that, in the human subject with an infected biliary tree, the danger of ascending cholangitis is slight and that the biliary fistula does not close in the presence of a patulous common duct.

7. Cholecystenterostomy is a comparatively minor intra-abdominal operation. It has a low mortality; gives few post-operative complications; gives continuous drainage of the biliary tree and furnishes an additional functional bile duct where there is common duct pathology. (Fig. 2.) In general it seems to be the operation which does the most good with the least harm and tends to eliminate the patient

who returns to haunt the office of the operator following a needless cholecystectomy.

8. In our hands cholecystogastrostomy is preferred to cholecystoduodenostomy.

I am indebted to Dr. H. T. Caswell for the compilation of the statistics of the most recent group of 100 cases.

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# GENERAL PRINCIPLES IN THE TREATMENT OF THE COMMON TYPES OF STASIS ULCERS\*

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FOR simplification and ease of description, let us divide the common types of stasis ulcers into two classes. To the first class are assigned those ulcers associated with chronic venous insufficiency primarily due to the incompetency of the superficial veins of the involved extremity. To the second class are assigned those ulcers whose etiologic basis usually can be traced directly to damage brought about by an attack or attacks of thrombophlebitis. In all instances, let us assume that we are dealing with ulcers of average size, shape and location which are producing average debility and symptoms. Ulcers, which because of their magnitude or severity of associated symptoms require additional therapy other than herein presented, will not be considered.

Before instituting therapy for any ulcer of the lower extremity a thorough history should be recorded and local, general and laboratory examinations should be completed. The history, in most instances, will determine to which of the aforementioned groups the ulcer should be assigned and will aid the operator in making a prognosis concerning the results to be expected from treatment. The general and laboratory examinations either should prove or disprove the tentative diagnosis of stasis ulcer. If complications or concomitant pathologic lesions should be uncovered, they can in most instances be remedied to the patient's benefit. The local examination of the extremity, particularly that of the venous systems, should be carried out prior to the institution of any type of therapy, because often a few days of rest and elevation of the part may minimize the pathologic signs and symptoms or

may cause one to misinterpret the true pathologic condition of the veins.<sup>1</sup>

The physician's main interest and responsibility is to heal the ulcer or ulcers that are present on the extremity as rapidly as possible. His next responsibility is to maintain the extremity free from further ulcerations and to restore to that extremity as much of an adequate circulation as is possible.

It must be remembered, however, that adequate continued improvement will not be maintained unless the patient understands and will cooperate. For this reason attempts to have each patient understand the objectives of treatment are important, particularly that of the pressure pad and external support, for the application of which the patient is primarily responsible.

Usually treatment of the first aforementioned class does not offer as many problems as that of the second class. In most cases it can be shown definitely that the incompetency of the varicosities was responsible for the stasis that predisposed to the formation of the ulcer.

The usual history encountered among these individuals is as follows. Varices were noted at an early age, accompanied by the usual symptoms; then gradually, more or less in the following order there developed the evidence of continued stasis: pigmentation, edema, atrophic changes of the skin with loss of elasticity, brawny infiltration and, frequently, dermatitis. It can be seen readily that if, after such a situation has developed, some mechanism or accident causes a break in the epithelium in this region, the onset of an ulcer would occur, as is so often the case. Without adequate therapy at this stage

\* From the Section on Postoperative Care, Mayo Clinic.

the ulcer will progress, no doubt owing to the stimulation of the secondary infection of the wound. The tissues and skin are not able successfully to ward off progression of this lesion because of the inadequate circulation.

The ulcers, in themselves, are frequently identical regardless of the class to which they are assigned. It is by the characteristics of the tissues that surround the ulcer that one can often identify the type of ulcer at a glance. Those extremities that have previously been involved by thrombophlebitis more frequently will demonstrate discoloration, pigmentation, edema, dermatitis, brawny infiltration and a low grade of cellulitis to a more marked degree than those of the first class. Frequently varices are not found on inspection, but by palpation in most instances their detection is not difficult.

#### TREATMENT

The general examination of the patient usually requires two or three days. During this period he is requested to remain quiet as much of the time as is possible with the extremity elevated to an angle of about 30 degrees and enclosed in warm moist packs of aluminum subacetate (0.5 per cent). This procedure has a twofold value: It rapidly controls the secondary infection and greatly reduces the edema. When the patient is ambulatory, external support is applied, usually in the form of elastic bandages, to maintain the extremity as free from edema as possible. If the general examination has not revealed any contraindications, the offending varices are obliterated. The methods employed depend on the type and amount of involvement.

Throughout the following week to ten days in which obliterative therapy is being instituted, the rest, elevation of the extremity and application of packs are continued whenever convenient. By this time the ulcer has usually reacted well and granulation tissue has partially or completely filled in the defect depending on the size of the lesion. The local therapy for the ulcer in

most instances is minimal. As previously mentioned, the packs combat the secondary infection and elevation of the extremity reduces the edema and improves the circulation, thus in turn promoting the formation of granulation tissue. When this regimen is no longer indicated, any bland soothing ointment may be employed, primarily to prevent the dressings from adhering to the ulcer. At the Mayo Clinic we employ 3 per cent ichthammol (ichthyl) in zinc oxide for this purpose.

If more support to the extremity than the elastic bandage seems indicated, after the obliterative therapy has been completed and the local reaction to the sclerosing solution has subsided, a small dressing is applied over the ulcer, an air-foam rubber sponge is cut to the size and thickness desired and the leg is encased from the instep to just below the knee in an adhesive elastic cast which is to remain intact for five or six days or twice that period, depending on its comfort and usefulness. Excessive discharge is eliminated if the cast is applied with the proper pressure.

We never apply these elastic casts directly to the ulcer and, if there seems to be a possibility that the patient may be sensitive to the cast, the leg is covered with a bandage or stockinette before this elastic cast is applied.

Usually such a cast applied once or twice suffices to heal the ulcer entirely. If not, use of such casts may be continued as indicated. In most cases, support to the leg should be continued for six months to a year, depending on the success encountered in eliminating the edema. Elastic bandages 3 inches (7.5 cm.) wide are generally most useful for this purpose.

On dismissal the patient is carefully instructed in the care of the skin of the involved extremity or extremities. A bland oil such as olive oil should be applied daily to prevent scaling or cracking of the epithelium.

*Treatment of Ulcers of Class 2.* The status of the superficial systems determines

the treatment to be employed if the deep circulation is adequate and is functioning satisfactorily.<sup>1</sup>

If the deep circulation is not adequate, obliterative therapy must not be undertaken. Palliative therapy, such as rest, elevation and packs to control the secondary infection and edema at the onset and then the application of adequate external support, is the treatment of choice. However, if the deep circulation is functioning, therapy as previously instituted in class 1 can be carried out. It must be remembered that thrombophlebitis, besides damaging the venous system, also in practically every instance causes additional damage to the lymphatic system; thus, there occurs the usual increased and persistent edema associated with this class of ulcers.

It will be seen that additional external support other than elastic bandages is usually indicated to eliminate the edema and to allow the extremity to rehabilitate itself, particularly from the damaged lymphatic system.

Therefore, detailed instructions are given the patient in the use of Para gum rubber bandages. The ulcer or area of previous ulceration is covered in the usual way with plain gauze. If there is still slight discharge 3 per cent ichthammol (ichthyol) in zinc oxide on gauze and then a small, thin airfoam sponge are put in place. A white cotton stocking is used and should cover the whole leg to prevent the direct contact

of the rubber bandage with the skin. The patient is requested to remove and reapply the cotton stocking twice a day or more frequently and never to wear one that has not been washed thoroughly; otherwise irritation, excoriation or folliculitis may develop.

The patients soon learn to apply the Para gum rubber bandages with considerable dexterity. By continued use of these bandages, employing the local hygiene as recommended, the ulcer should heal and remain healed and the condition of the extremity should continue to improve as exemplified by the increase in the elasticity and more normal general appearance of the skin.

Bandages must be worn for at least one or two years; the time depends on the improvement noted and the judgment of the physician. It is seldom that the use of bandages will be necessary throughout the patient's life.

It may be seen that the treatment for the two types of ulcer is essentially the same, except that in class 2 there may or may not be varicosities to be obliterated, depending on the status of the deep circulation, and that additional external support is necessary because of the usual additional lymphatic stasis.

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# FIBROMA OF THE MUSCULOFASCIAL LAYERS OF THE ABDOMINAL WALL (DESMOID TUMORS)\*

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**D**ESMOID tumors are of interest because of their comparative rarity and the fact that they are benign and usually lend themselves to surgical excision with permanent cure if all the tumor is removed. The name desmoid was first used in the description of these tumors by Müller (1838) and indeed the word was well chosen as it represents a contraction of the two Greek words, *desmos*, a band or tendon, and *eidōs*, appearance; thus the word describes a tendinous appearing tumor. Although Müller had the pleasure of naming the tumor, these fibromas apparently had been described previously by Macfarlane (1832).

In this paper I am concerned only with desmoid tumors of the musculofascial layers of the abdominal wall although similar tumors also occur in other regions, for instance in the pectoralis major, rectus femoris, gluteus, sternocleidomastoid, digastric, biceps, extensor carpi ulnaris, hamstring and masseter muscles and scapular region. They do not appear in these regions, however, with the frequency in which they are found in the abdominal wall. A recent analysis of all desmoid tumors seen at the Mayo Clinic revealed that in fifty-five or 71.4 per cent of the total of seventy-seven cases, the tumor arose in the abdominal paries.

In these fifty-five cases, women were affected more often than men for 72.7 per cent of the patients were females. Patients who had desmoid tumors were most often between the ages of 20 and 40 years. Stone found the right lower part of the abdominal wall to be involved more frequently than any other portion of the abdomen.

Although the exact etiologic factor is unknown, several observations seem to

indicate that these fibromas result from trauma to the abdominal wall with hemorrhage and that the characteristics of a tumor are assumed during the process of organization of the hematoma. Bearing this out are the following observations: (1) Frequently there is a history of trauma to the region; (2) the tumors have been observed in the scars of previous surgical incisions, and (3) they are more common among women, most of whom have been pregnant one or more times, and it is possible that small hematomas may have occurred as a result of the rupture of a muscle during labor. In the series from the Mayo Clinic, 62.5 per cent of the women with desmoid tumors had been pregnant.

The gross and microscopic appearance of these tumors as well as the question of malignancy is well covered by Pearman and Mayo. They stated that a freshly removed tumor is dense, hard and tough, and creaks under the knife. The cut surface bulges, is a white or pinkish color, glistens, and the interlacing bundles of white fibrous tissue can usually be seen without difficulty. The larger tumors tend to be soft in the center, either from edema or mucoid degeneration, and some are cystic. Changes in the skin covering the tumor are unusual and involvement of the lymph nodes occurs seldom if at all.

The histologic picture is that of a rather cellular fibroma occurring in striate muscle. The central portion of the tumor is older than the peripheral portion. The elongated adult fibrous tissue cells run in strands and bundles which are interlaced in all directions after the manner of the unstriate muscle bundles in a uterine fibroid.

At the periphery where the tumor infiltrates the surrounding muscle, the tumor

\* From the Division of Surgery, Mayo Clinic.

tends to be somewhat more cellular. There is no capsule or definite line of cleavage between the tumor and the adjacent muscle. When the tumor is bounded by a fascial plane, an appearance of encapsulation is produced. In spite of the infiltration there is no evidence of a sarcomatous change, such as nuclei containing large amounts of darkly stained chromatin or large multiple nucleoli, both of which are indications of rapid proliferation. Normal adult blood vessels may be noted throughout most of the tumors. The presence of these vessels indicates the slow growth of the tumor.

The special features of the tumor are the inclusion of striate muscle fibers and the sequence of regressive changes. The earliest change may be seen at the periphery of the tumor where the striate muscle is being infiltrated and broken up into constituent fibers.

The muscle fibers appear to be stretched and attenuated. They are irregular in outline and the transverse striations tend to disappear. Here and there are strands resembling unstriate muscle and foreign body-like giant cells derived from this muscle probably because of faulty nutrition.

It is easy to see that failure on the part of the surgeon to remove the tumor completely would leave strands of interfibrillar desmoid tissue and result in a local recurrence of the tumor.

The patient usually consults his physician because of finding a small hard lump (usually 3 to 8 cm. in diameter) in the abdominal wall or the patient even may have been entirely unaware of its presence until it was pointed out as a result of a general physical examination. Usually there are no subjective symptoms unless the tumor is large; then of course a dragging sensation and occasionally actual pain will be present. Walters and Church found that only a fourth of the patients in their series mentioned pain or soreness. On examination the lump is found to be fixed in the abdominal wall and seems more superficial to palpation than the usual

intra-abdominal mass. It is smooth and discrete, moves with the rectus muscle and does not have the characteristic shift that

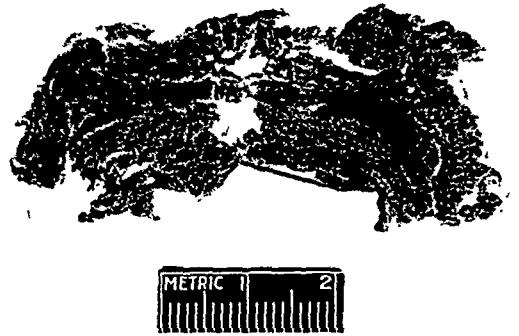


FIG. 1. Specimen removed at operation and halved showing the cut surfaces of the rectus muscle and desmoid tumor.

some intraperitoneal tumors have with deep inspiration. It is not attached to the skin and this fact helps distinguish it from a keloid. Desmoids in the abdominal wall have been mistaken for hydrops of the gallbladder, stone in the gallbladder, tumor of the omentum or mesentery, pancreatic cyst and tumor of the uterus, kidney and bone. A positive diagnosis, of course, can be made only by microscopic examination of the tumor.

Wide, surgical excision of the tumor is the treatment of choice. If the tumor is small, it may be excised to advantage in its entirety before microscopic examination confirms the diagnosis because the small tumor presents no difficulty in reconstruction of the abdominal wall. On the other hand, when a large tumor is present for which wide excision is necessary and proper reconstruction of the abdominal wall is likely to be difficult, it seems wise to confirm the diagnosis by biopsy before subjecting the patient to an extensive operation. It is doubtful whether radium therapy has any curative value in dealing with this variety of tumor.

Pearman and Mayo's recent study indicates that desmoid tumors are definitely benign and that the so-called recurrences which led previous observers to believe that some of the recurrences must be low grade malignant tumors are in effect the

result of incomplete removal. They found that many patients who had these recurrences have remained cured for years after

noted a small tumor. In the next four months it enlarged to the size noted on admission. There had been no pain or discomfort.



FIG. 2. The rectus muscle is shown on the left and the desmoid tumor on the right (low power magnification).



FIG. 3. Typical structure of desmoid tumor (medium power magnification).

subsequent complete operations. These observations emphasize the necessity of wide primary excision as advocated as early as 1915 by Balfour.

The case history of a desmoid tumor which I removed is noteworthy because the patient was a male child, there was a definite history of trauma and the tumor was adherent to the costochondral juncture.

#### CASE REPORT

The patient was a boy aged 5 years. He was born prematurely at approximately 6 months according to the mother and forceps were used during the delivery. His development had been normal and he had been ill only once, this was at the age of 13 months and a diagnosis of chickenpox had been made. Except for tonsillectomy and adenoidectomy at 4½ years he had had no operations.

One and a half years prior to admission to the Mayo Clinic, when the child was 3½ years old, he had fallen off the bed injuring the right upper part of the abdomen. One month after the injury the doctor in his home locality had

Physical examination revealed a healthy, well-developed boy without any abnormality except for a firm mass in the right upper part of the abdominal wall which seemed discrete and was three to four inches (7 to 10 cm.) in diameter. The laboratory data revealed nothing abnormal. A roentgenogram of the abdomen did not reveal calcification. The diagnosis was indeterminate although the possibility of an unresolved hematoma of the rectus muscle was entertained. Exploration and biopsy were advised. With the patient under nitrous oxide, oxygen and ether anesthesia, the tumor was explored through an upper right rectus incision and was found to be a desmoid involving the rectus muscle. It was necessary to remove a considerable portion of the rectus muscle and its sheath to extirpate the tumor which was adherent at the anterior costochondral junction and knife dissection was required to free it from the cartilage. The abdominal wall was closed with chromic catgut in the usual anatomic layers and the child's convalescence was without event. He was dismissed sixteen days later at which time the wound was healed.

The pathologists reported that the material removed consisted of a portion of right rectus

muscle and desmoid measuring 5 by 2.5 by 1 cm. (Figs. 1 to 3.)

#### SUMMARY

Desmoid tumors in many instances apparently arise secondary to trauma and their pathogenesis probably is related to a disturbance in the organization of the ensuing hematoma. Recent careful pathologic study of a large series of specimens removed at operation together with an analysis of the patients' subsequent post-operative histories indicate that these tumors are benign. The treatment of choice is wide surgical excision.

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# THE TRANSFUSION OF CONSERVED BLOOD

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WHOLE blood for conservation can be obtained from three sources, the living donor, the human placenta, and the human cadaver. The living donor is the most frequent source, for the amount available from the average placenta is not large, and for obvious reasons the use of blood from the cadaver has not become popular in this country, although Judine<sup>1</sup> and other Russian writers strongly advocate the method.

## COLLECTION

Whatever the source of the blood, its collection and storage must be carried out with rigidly aseptic precautions. Caps, masks and sterile gowns and gloves should be worn by the collecting team. A minimum of handling is essential. The blood should be collected in the same container in which it is to be stored and from which it will be administered later. The container is sealed as soon as the blood has been collected and is placed immediately in the refrigerator, at the optimal temperature of 5°C. Not more than 500 cc. should be collected and stored in a single flask.

Blood from the living donor is collected in the usual manner, which need not be set forth here. Placental blood is collected as follows:

As soon as the child is born the umbilical cord is clamped in two places with hemostats and is divided 5 or 6 inches from the umbilicus. The severed distal end is cleansed with alcohol or tincture of iodine, and, after the operator has put on a fresh pair of sterile gloves, is passed through a hole in a sterile towel. The blood is permitted to flow through a funnel into a sterile container in which the proper quantity of some anticoagulant fluid has been placed. The flow may be accelerated by

gentle massage of the fundus uteri. The average yield of blood from each placenta is 50 cc.

The method of collecting blood from the cadaver is described by Judine<sup>1</sup> and other Russian writers as follows:

The cadavers to be used are those of young, healthy adults who have died suddenly from accidental causes. The blood is collected from two to six hours after death under strict aseptic precautions. The jugular vein on the right side is exposed by a small incision between the clavicular heads of the sternomastoid muscles and is lifted with two hemostats, so that ligatures can be passed beneath it. The vein is then opened and two U-shaped cannulae are inserted into it, one directed toward the heart and the other toward the brain. They are connected with sterile collecting flasks by means of sterile rubber tubing. No anticoagulant is necessary since cadaveric blood does not clot. When the body is tilted into the Trendelenburg position, blood readily flows from the cannulae into the flask. The amount of blood which can be obtained from a cadaver varies from 1,500 to 4,000 cc.

## PRESERVATIVE AND ANTICOAGULANT SOLUTIONS

Each of the solutions which can be utilized for the conservation of whole blood has certain advantages. Glucose-citrate solutions, for instance, preserve blood more effectively than simple citrate solution. The various types of solution and the proper proportions of each follow:

1. 6 per cent sodium citrate solution, 10 cc. to each 100 cc. of blood.
2. 3.8 per cent sodium citrate solution, 10 cc. to each 100 cc. of blood.

3. 5.4 per cent glucose and 0.6 per cent sodium citrate solution, 100 cc. to each 100 cc. of blood.

4. Institute Hematologic Technique (I.H.T.) solution, 100 cc. to each 100 cc. of blood. I.H.T. solution consists of:

Sodium citrate.....	7	Gm.
Sodium chloride.....	5	Gm.
Potassium chloride.....	0.2	Gm.
Magnesium sulfate.....	0.004	Gm.
Distilled water to make 1,000 cc.		

All of these solutions have proved satisfactory in actual use provided that the blood is not conserved for longer periods than ten days. Other solutions, such as transfusol (sodium polyacetylen-di-sulfonate) have been recommended but do not offer any special advantages (Lattes and Rettani<sup>2</sup>).

Since heparin has been available in purified form (Schmitz and Fischer,<sup>3</sup> Charles and Scott<sup>4</sup>), it has been employed in transfusions and has proved useful when the blood is used immediately after its withdrawal (50 cc. of isotonic sodium chloride solution containing 3 to 5 mg. of heparin for each 600 cc. of blood). Although the status of heparin in relation to the conservation of blood is still in doubt, its use for this purpose has been recommended by Sköld<sup>5</sup> (25 cc. of isotonic sodium chloride solution containing 3 to 4 mg. of heparin for each 100 cc. of blood).

#### CHANGES IN CONSERVED BLOOD

The changes which occur in blood during conservation are influenced by a variety of factors, the most important of which are contamination, trauma to the blood during collection, the form of the container, the type of preservative solution and the source of the blood. Blood may be conserved for longer periods of time in tubular than in wide-bottomed flasks (Scudder et al.<sup>6</sup>). The glucose-citrate mixture, as has been mentioned, is probably the most effective preservative, but it is difficult to sterilize. Blood from the living donor can be kept for longer periods than

placental blood, and placental blood can be kept longer than cadaveric blood.

The method of conservation of blood employed in the Blood Bank at Johns Hopkins Hospital (Ravitch<sup>7</sup>) is both simple and safe.

Even when conditions are optimal, certain changes in the conserved blood occur:

1. Leukocytes rapidly diminish in number, particularly the polynuclear cells, and their phagocytic activity decreases considerably after the first twenty-four hours of storage.

2. The blood platelets soon begin to disappear, and those which still remain exhibit marked alterations of structure by the sixth day.

3. The red blood cells become less numerous, their fragility increases and their hemoglobin content decreases. Even under optimal conditions hemolysis appears from the eighth to tenth day of conservation. The oxygen-carrying capacity of the erythrocytes which remain viable is usually normal for a period of ten days (Rous and Turner<sup>8</sup>).

4. Definite biochemical changes occur. The sugar diminishes, as a result of glycolysis, and lactic acid accumulates. The carbon dioxide content increases and the oxygen content decreases. The specific gravity rises and the surface tension diminishes. The glutathione content undergoes a rapid reduction (Kiguchi<sup>9</sup>). Inorganic phosphorus, uric acid, nonprotein nitrogen, polypeptides and aminoacids increase in amount.

5. It is generally agreed that the prothrombin content of stored blood decreases, although some divergence of opinion exists regarding the rapidity of the diminution. Rhoads and Panzer,<sup>10</sup> using a modification of the Quick method, found a loss of half of the total initial amount of prothrombin during the first three days of conservation. DeGowin,<sup>11</sup> on the other hand, using the method devised at the University of Iowa, found the prothrombin content of the stored blood not much reduced until the fifteenth day.

TABLE I  
REACTIONS FOLLOWING CONSERVED BLOOD TRANSFUSION

Author	Source of Blood	Preservative Solution	Number of Transfusions	Incidence of Reactions, Per Cent	Nature of Reactions
Kiguchi	Donor	Sodium citrate	53	15	Headache, urticaria
Fantus (Cook County Hospital).	Donor	Sodium citrate and sodium chloride	962	13.5	Not stated
Wilson and Jamieson	Donor	Sodium citrate	14	14.2	Rigor, fever
Sammartino	Donor	Glucose citrate	167	8.3	Rigor, fever, lumbar pains
Tachella Costa	Donor	Not stated	11	54.5	Rigor, fever
Jonesco	Donor	Sodium citrate	2	0	
Vlados	Donor	I.H.T.	22	9.0	Rigor, fever
Domanig	Donor	I.H.T.	18	11.1	Rigor, fever, hemoglobinuria
Jeanneney and Viero	Donor	Sodium citrate	70	8.5	Rigor, fever, transient hemiparesis
Gnoinski	Donor	Sodium citrate	6 Blood conserved for 60 to 90 days	83.3	Rigor, fever, hemoglobinuria
Cameron and Ferguson (Philadelphia General Hosp.).	Donor	Sodium citrate	1000	7.4	Rigor, fever, hemoglobinuria
Elliott, Macfarlane and Vaughan	Donor	I.H.T.	50	20	Rigor, fever, jaundice
Boland, Craig and Jacobs	Donor, Placenta	I.H.T.	38	10.5	Not stated
Robertson	Donor	Glucose citrate	22	4.5	Rigor, fever
Picinelli	Placenta	Sodium citrate	5	40	Hemoglobinuria, rigor, fever
Gwynn and Alsever	Placenta	Glucose citrate and sodium chloride	18	11.1	Rigor, hematuria
Page, Seager, and Ward	Placenta	Sodium citrate and sodium chloride	25	Several, one severe	Not stated
Halbrecht	Placenta	Sodium citrate	116	3.4	Rigor, dyspnea, tachycardia
Grodberg and Carey	Placenta	Sodium citrate	75	4.0	Not stated
Judine	Cadaver	None	1000	12.5 (5 deaths)	Rigor, fever, hemoglobinuria, jaundice, diarrhea
Shamov	Cadaver	I.H.T.	42	14.2	Not stated
Bellelli	Cadaver	I.H.T.	47	29.7	Rigor, fever, albuminuria, vomiting, diarrhea, jaundice
Judine and Skundina	Cadaver	None	350	21.0 (5 deaths)	Hemolytic shock, anaphylactic shock
Skundina	Cadaver	None	200	21.0 (4 deaths)	Anaphylactic shock, hemolytic shock, phlegmon of arm

6. The free potassium content of the plasma increases with conservation, due to its diffusion from the red blood cells (Dulière,<sup>12</sup> Jeanneney and Servantié<sup>13</sup>) and the accumulation may be the cause of post-transfusion reactions (Scudder et al.<sup>6</sup>).

#### METHOD OF ADMINISTRATION

The conserved blood should be administered directly from the flask in which it has been stored, after its compatibility with the blood of the prospective recipient has been determined. It should be filtered through six or eight layers of gauze before it is transfused.

Warming of the blood must be done with the greatest care, and during the process the flask should be gently rotated, in order to mix the plasma and cellular elements. Excessive heating will lead to coagulation of the plasma proteins, which will result in severe post-transfusion reactions. For this reason several workers prefer to use unheated blood, which has apparently given satisfactory results (Wilson and Jamieson<sup>14</sup>). By this method the blood is allowed to remain at room temperature for several hours after it has been removed from the refrigerator. The rate of administration should not exceed 10 cc. per minute. Slowing of the flow is frequently caused by a spasm of the vein wall as unheated blood is administered.

The amount of blood to be administered depends upon the indications for the transfusion. Patients suffering from shock may be given 500 to 1,000 cc. Judine<sup>1</sup> has given as much as 1,500 cc. at a single transfusion. The use of placental blood is less practical when large amounts are required. The pooling of blood from several placentas may be considered, but this method increases the incidence of post-transfusion reactions.

#### INDICATIONS

The indications for transfusion with conserved blood do not differ from the indications for transfusion with fresh blood. They include hemorrhage, with or without

shock, anemia due to repeated hemorrhage, anemia due to sepsis and acute septicemias.

The contraindications to transfusion with conserved blood are not yet clear, but certain precautions should obviously be remembered when this method is employed. Blood which has been stored longer than twenty-four hours should not be used when a hemostatic effect is desired. Opinions differ, as has been pointed out, as to when the prothrombin content of the blood begins to decrease, but in view of the findings of Rhoads and Panzer that the fall begins at the end of twenty-four hours, it is clearly safer not to use conserved blood for hemostatic purposes after this time. Furthermore, since the phagocytic activity of the leukocytes decreases in conserved blood, it is inadvisable to perform transfusion with it for acute infections after more than forty-eight hours of storage.

#### CLINICAL RESULTS

The experiences of observers in widely scattered areas would seem to indicate that the clinical results of transfusion with conserved blood do not differ greatly from those of transfusion with fresh blood. There are, however, distinct disadvantages to the use of conserved blood, including:

1. Great dilution of the blood, associated with the use of certain preservative solutions.
2. A less effective augmentation of the number of red blood cells and hemoglobin content of the blood of the recipient, due to the changes in these respects in the conserved blood.
3. A higher incidence of post-transfusion reactions.

#### POST-TRANSFUSION REACTIONS

Considerable difficulty is encountered in attempting to evaluate the statistical incidence of reactions following transfusion with conserved blood, chiefly because of the variation of criteria used by different workers. From available data, however, certain general statements can be made (Table 1):



1. In a total of 2,373 collected transfusions of conserved donor blood the incidence of reactions was 13.8 per cent.\* In a total of 214 collected transfusions with conserved placental blood the incidence of reactions was 14.6 per cent. In a total of 1,639 collected transfusions with conserved cadaveric blood the incidence of reactions was 19.6 per cent. The severest reactions and the only fatalities on record followed the utilization of conserved cadaveric blood. The reactions varied from mild rigors and elevations of temperature to icterus, hemoglobinuria, hematuria, diarrhea, vomiting, and anaphylactic and hemolytic shock.

2. Attempts to decrease the number of reactions in the future use of this method will depend upon:

(A) Improved methods of collecting, storing and administering conserved blood.

(B) A more detailed knowledge of the physiological and chemical changes which occur during the conservation of the blood.

(C) Clearer delimitation of the indications for and contraindications to transfusion with conserved blood. At the present time, as has been pointed out, the contraindications are largely unknown.

#### SUMMARY

A brief résumé has been given of the technic and results of transfusion with conserved blood. Conserved blood from a living donor is superior to blood obtained

from the placenta or the cadaver but is inferior to fresh blood from a living donor.

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\* In making up these tabulations the series recorded by Gnoinski<sup>15</sup> has been omitted. He used blood which had been conserved for periods of sixty to ninety days and reported reactions in 83.3 per cent of his cases.



# ARTIFICIAL PNEUMOTHORAX

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THE term, "artificial pneumothorax," or more properly, induced pneumothorax, as ordinarily used means air within the pleural cavity which has been introduced by *mechanical* means, rather than spontaneously or traumatically. Forlanini, in 1882, and J. B. Murphy, in 1898, independently of each other, described patients with pulmonary tuberculosis who had been benefited by induced pneumothorax, and it is still in this disease that the procedure has its widest applications.

*Indications.* The indications for induced pneumothorax in pulmonary tuberculosis are mainly: (1) progressive lesions; (2) cavities and (3) hemorrhage. There is, however, a great difference of opinion as to the indications in different stages of the disease, so that a tabulation that would be universally accepted is not possible. The following may be listed: (1) infiltrative lesions, with or without small cavities and with positive sputum which do not improve after a short trial of bed rest; (2) larger cavities; (3) pneumonic lesions confined to one lobe; (4) early infiltrative lesions with negative sputum which do not respond to a period of three to six months of bed rest, and (5) profuse or protracted hemoptysis. Contraindications are: (1) bilateral, far advanced disease; (2) markedly impaired respiratory reserve as indicated by dyspnea at rest or upon slight exertion, or by a vital capacity of less than 1200 to 1500 cc.; (3) decompensated cardiac or renal disease, and (4) active hematogenous tuberculosis with extensive extrapulmonary involvement.

Induced pneumothorax finds application in the diagnosis and treatment of several nontuberculous thoracic diseases. In the hands of some, including the author, it has been beneficial in the early stages of

suppurative bronchiectasis. Most thoracic surgeons require a short period of pneumothorax preliminary to exploratory thoracotomy for pulmonary or mediastinal tumors; this serves the twofold purpose of stabilizing the mediastinum and of accustoming the patient to increased demands on his respiratory reserve. Pneumothorax is sometimes of value as an aid in the roentgenographic differentiation of chest wall tumors and other extrapleural masses from intrapulmonary lesions.

The induction of a pneumothorax should be performed in a hospital or sanatorium where the patient can be closely observed until the lung is well collapsed, and preferably until cavity closure has been effected. The technic described is that which is used on the Division of Pulmonary Diseases of Montefiore Hospital. Many variations in one or more of the steps are practiced, some of which will be noted.

*Apparatus.* A pneumothorax apparatus (Fig. 1) is required. Many different ones have been devised, all of which contain two essential elements: (1) a manometer\* (A) for the measurement of intrapleural pressure, and (2) a mechanism to drive air into the pleural space. Most apparatuses used in this country feature a two-bottle arrangement in which the level of water in one, (E), can be raised above that in the other, (D). The flow of water thus created forces the air in the lower bottle into a rubber tube, (F), which can be connected to the puncture needle. By means of valves, the continuity of the tube with the manometer (valve B), and the flow of air, (C), can be controlled; both valves should not be open at the same time. The gas used is ordinary room air which is filtered through

\* A water manometer is the most satisfactory.

cotton, (G), placed at one point in the tubing. It is no longer believed that the use of nitrogen, carbon dioxide, etc., has

# TECHNIC

Ordinarily, no preliminary medication is required. The patient is placed in the

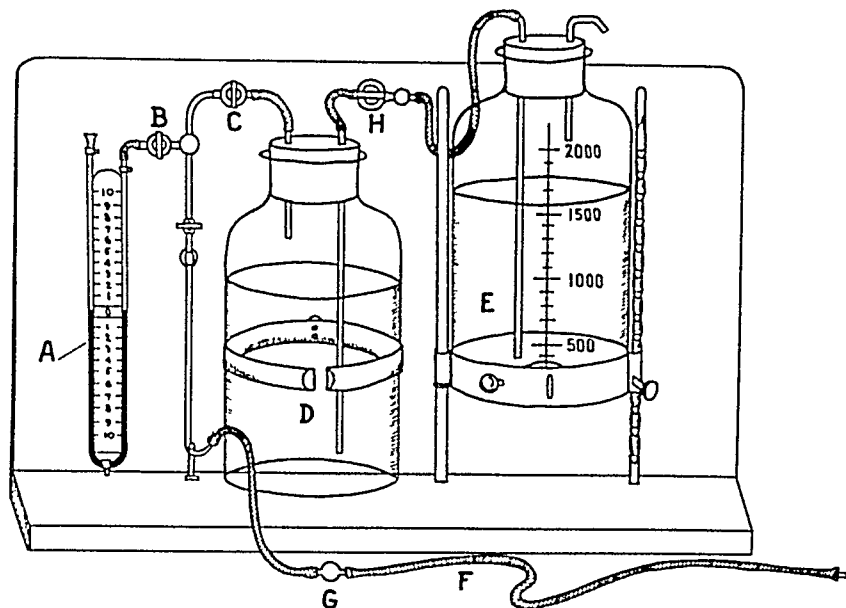


FIG. 1. Pneumothorax apparatus. A, water manometer. B, valve controlling continuity of rubber tube with manometer. C, valve controlling continuity of rubber tube with lower bottles; by means of this, the flow of water can be regulated. D, bottle containing water and air. E, graduated outer bottle which can be elevated or lowered so that water will flow out of or into it. F, rubber tube, the end of which can be attached to the puncture needle. G, cotton filter. H, valve between the two water bottles; this is ordinarily kept open.

any advantage. The author personally finds great satisfaction in the use of the Davidson apparatus.\*

A sterile tray is provided, containing a three-way stopcock (Fig. 2A), several 2 cc. hypodermic syringes,  $\frac{1}{2}$  inch 26 gauge needles, puncture needles (Fig. 2B), 3 medicine glasses (for alcohol, iodine and 1 per cent procaine), applicators, gauze pads and towels.† The puncture needles should be 18 gauge and 2 inches long, though for the average sized chest, a length of  $1\frac{1}{2}$  inches is sufficient. The needle should have a short bevel and its point should be sharp enough to permit easy penetration of the chest wall, yet blunt enough to minimize the possibility of puncturing the lung. Ampoules of caffeine and epinephrine are kept in the treatment room at all times.

lateral recumbent position with the operated side up. A pillow is folded and placed under the chest so that the thorax is at a higher level than the head and feet. The operator stands at the patient's back and the pneumothorax apparatus is placed in front of him, thus distracting his attention from the manipulations incident to the puncture. An assistant regulates the apparatus. The site selected for the puncture should be well away from the diseased area. Since, in most cases, the lesions are in the upper lobe, a favored location is the sixth or seventh interspace in the mid-axillary line.

The field is sterilized and draped. The author prefers a thorough scrub-up to using gloves. The selected site is infiltrated with a local anesthetic as deeply as a  $\frac{1}{2}$  inch needle will reach.\* The valves of the

\* Manufactured by J. Sklar, Brooklyn, N. Y.

† A towel 1 foot square with a reinforced hole about 4 inches in diameter in the center is useful.

\* Many advocate infiltration down to the parietal pleura.

pneumothorax apparatus are set for manometric registration (by opening *B* and closing *C*). Oscillation of the manometer

is carefully watched for movement, and it is occasionally depressed a little to clear the needle of tissue plugs. When the

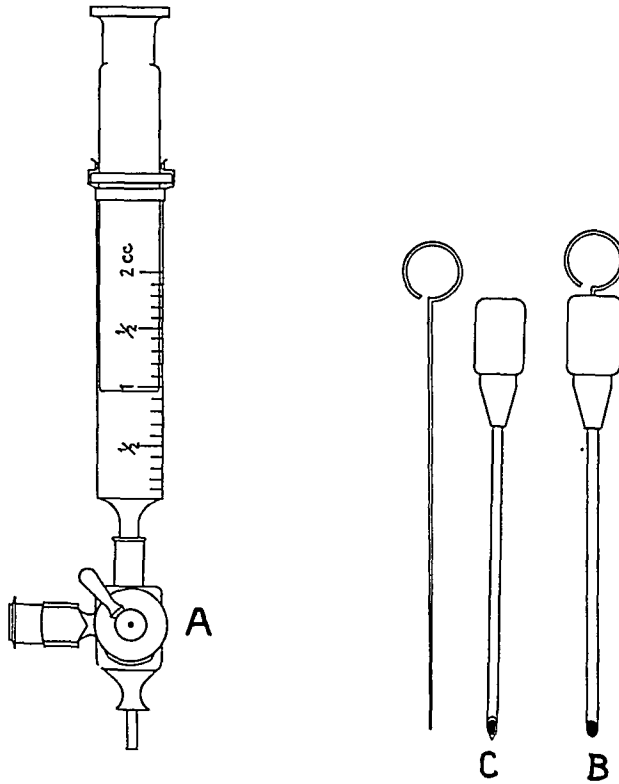


FIG. 2. A, three-way stopcock with attached syringe.  
B, blunt needle suitable for induction of pneumothorax.  
C, sharp needle used for refills.

when the rubber tube is squeezed confirms the patency of the system. The puncture needle is now connected to the three-way stopcock into the opposite end of which is inserted a hypodermic syringe almost full of anesthetic solution; the stopcock is set so that the needle and syringe are in communication and then the rubber tube of the pneumothorax apparatus is attached to the sidearm. The needle, held vertically to the chest, is thrust into the skin\* and slowly pushed deeper and deeper; the rapidity of insertion depends upon the skill and experience of the operator. At this point the patient is cautioned to avoid coughing, talking or deep breathing, any of which may cause sudden expansion of the lung against the needle.

The position of the piston of the syringe

\* When a very blunt needle is used, a preliminary opening in the skin may be made with a sharp needle.

parietal pleura is punctured, a slight snap will often be transmitted to the fingertips. More important, if the tip of the needle is in the pleural cavity, the piston will begin a fairly rapid descent as a result of the negative pressure within the space. It is then necessary to make sure that the needle is not in the lung; this is indicated if gentle traction on the piston causes air or blood to enter the syringe. Unless this occurs, the stopcock is then turned so that the needle is in communication through the rubber tube with the manometer of the apparatus.\*

\* Several other methods of locating the pleural space are satisfactory. Some prefer to have the stopcock set so that the needle is in communication with the manometer when the puncture is being made, and to watch for the appearance of true intrapleural readings. Others use an unconnected needle filled to the hub with fluid, sudden inward suction of which indicates entry into the pleural cavity.

If the tip of the needle is truly within the pleural space, there should be an immediate negative reading on the manometer. This will then oscillate synchronously with the phases of respiration, being lower (more negative) on inspiration, but negative during both inspiration and expiration, with a minimum excursion of 3 cm.\* *No air should be introduced unless the manometer indicates characteristic intrapleural pressure readings.*

A small amount of air (25 cc.) is then given (by closing valve *B* and opening *C*) and a reading is taken. The presence of adhesions is indicated by a pressure change in a positive direction. If the adhesions are very extensive, the pressure actually will become positive and pain will appear. Another 25 cc. of air are introduced, then 50 cc., each amount being followed by a reading. Unless the pressure becomes quite positive (more than plus 6), the remainder of the desired amount may then be given. Except in a special situation such as hemothysis which requires a large initial collapse, about 250 to 300 cc. are usually sufficient.

Following the insufflation, the patient is kept in the treatment room for at least fifteen minutes, during which period the pneumothorax apparatus and the sterile instruments are left in place. This precaution permits prompt detection and treatment of a tension pneumothorax which may occasionally occur. The patient is required to remain in bed for the first 24 hours. Rather severe pleuritic pain may necessitate the liberal administration of codein.

Although it is often possible to suspect from the roentgen film that an adherent pleura will prevent induction of pneumothorax, one can be certain of this only by actually attempting the procedure. If a free pleural space is not located, a second attempt is made about two interspaces away. No more than three unsuccessful attempts should be made at one session,

\* A reading of minus 2, plus 2 indicates that the needle is in a bronchus.

and if similar failures occur on a subsequent day, further efforts should be abandoned.

A refill is given on the day following induction (the puncture being made close to the site of the original one) and every two or three days thereafter until the desired degree of collapse is achieved. For the first few refills, the technic is the same as that used for an induction, but is simplified by the fact that the entry of the needle into the pleural cavity is marked by the return of air into the syringe. Once the lung is well separated from the thoracic wall, a 20 gauge sharp needle (Fig. 2c) may be used; many prefer a single rapid thrust without previous anesthesia. When this technic is used, the author keeps the stylet in the needle almost to the tip during the puncture. After passage of the parietal pleura, it is pushed a little further, thus clearing the lumen of the needle.

#### COMPLICATIONS

Induced pneumothorax is subject to a number of complications. Only the more serious will be discussed:—

*A. Air Embolus.* This is the most dreaded complication of pneumothorax. It is caused by the entry of large quantities of air into a pulmonary vein. It most frequently occurs during induction, particularly when adhesions are present. It results from insufflation while the tip of the needle lies within a vein; or pleural or alveolar air may enter a vein if the surface of the lung, particularly in a fibrotic area, has been lacerated. The symptoms are abrupt in onset, vary in form and severity and are referable to embolization, especially of the brain. In severe cases, death may be almost instantaneous. Other symptoms are vertigo, headache, blurred vision, convulsions, syncope, cyanosis and blanching of one side of the tongue. The best treatment is prophylaxis; blunt needles should be used for induction, talking or coughing during insufflation should be forbidden and air should never be introduced unless the pressure readings are characteristically intrapleural. Once the accident has

occurred the patient's head is lowered, warmth is applied and stimulants are given.

*B. Tension Pneumothorax.* A laceration of the surface of the lung may occur as the result of a needle puncture, or spontaneously due to the tearing of an adhesion during forceful coughing. If the opening does not promptly seal itself, a tension pneumothorax will develop, and the mediastinum, if not fixed by adhesions, will shift toward the opposite side, causing an alarming degree of dyspnea. Prompt deflation then becomes necessary. The technic is the same as that used for insufflation, but the bottles of the apparatus are reversed. Following this, continuous deflation is necessary, often for several days. This is done by connecting the pneumothorax needle to a rubber tube whose other end is under water.\*

*C. Fluid.* A large number of patients with tuberculosis who receive induced pneumothorax sooner or later develop pleural effusions of varying amount and character. Most of these are relatively innocuous and eventually absorb; some, particularly those whose onset is marked by severe toxic symptoms, turn into tuberculous empyemas. Diagnostic aspiration should be performed frequently; large amounts may be withdrawn if dyspnea appears. The management of these effusions is the subject of great controversy; for details, reference may be made to the extensive literature on the subject.

*Adhesions.* In many cases it will become apparent within a few weeks after induction that adhesions are preventing satisfactory collapse of the diseased area. The involved portion may be so broadly adherent that only healthy lung is being collapsed, in which event the pneumothorax should be abandoned. If, however, the adhesions appear less extensive, a thoracoscopy should be performed by an experienced surgeon; in this procedure, the adhesions are inspected and, if possible,

severed (intrapleural pneumonolysis, Jacobaeus operation). It is thus often possible to convert an ineffective pneumothorax into a satisfactory one.

*After Treatment.* The most desirable degree of collapse is that which is just sufficient to be effective as indicated by the satisfaction of the following criteria: (1) cavity closure; (2) conversion of sputum,\* and (3) disappearance of symptoms, both local and constitutional. Once this collapse has been achieved, refills should be given just often enough for its maintenance at a *constant* level. The patient should be fluoroscoped before each refill, at which time the degree of collapse, position of the mediastinum and presence of adhesions or fluid are noted. Positive intrapleural pressures and undue shift of the mediastinum should be avoided. With the passage of time, thickening of the pleura may result in diminished absorption of air, so that the space can be maintained by small refills several weeks apart.

Most induced pneumothoraces become effective within a few months, if ever. The percentage of those becoming effective after this period diminishes with the passage of each succeeding month. When it becomes apparent that unseverable adhesions are preventing cavity closure, the procedure should be abandoned. If, however, all cavities appear to be closed, but the sputum remains positive, a bronchoscopic examination for the detection of tuberculous lesions of the trachea or major bronchi should be made. No fixed rule can be given for the length of time that a successful pneumothorax should be maintained. On our service we have set the arbitrary rule of continuing treatment for four years after cavity closure and sputum conversion. When the decision to discontinue pneumothorax has been made, no further refills are given, and the lung is watched by frequent fluoroscopic examinations until it has completely reexpanded.

\* More elaborate apparatuses for deflation are described in the reference texts.

\* Negative sputum implies that smears, cultures and guinea pig inoculations have been done on both sputum and gastric contents.

*Bilateral Pneumothorax.* In certain patients with bilateral disease, it is possible to treat both sides by induced pneumothorax. Usually the side with the more extensive lesion is treated first. It is best not to induce the second side until the first space is well established and thoracoscopy, if necessary, has been performed. The vital capacity should be determined to ascertain the ability of the patient to withstand bilateral collapse. After the second pneumothorax has been established, each side should be treated independently. However, respiratory embarrassment must be avoided by maintaining the smallest degree of collapse possible. Refills should

never be given on both sides on the same day.

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# STAB THORACOTOMY IN THE TREATMENT OF ACUTE PLEURAL INFECTION

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VARIOUS types of therapy, both medical and surgical, have been recommended in cases of acute pleural suppuration. These range in magnitude from needle aspiration to major thoracotomy with removal of segments of several ribs. Although certain authors have attempted to standardize the treatment of the condition, experience has indicated that the most satisfactory results are obtained by selecting the type of therapy best suited to the requirements of the individual case. This requires an appreciation not only of the advantages but also of the disadvantages of the various forms of treatment which have been proposed. Among the surgical methods, the most important minor procedure is stab (intercostal) thoracotomy. The advantages of this procedure include simplicity, freedom from shock and ease of performance. Thus it can be readily carried out under local anesthesia with only a few simple instruments. The patient, if very ill, need not be removed from bed, and if necessary the procedure can be performed at home as well as in the hospital. These features render it an excellent emergency method in the treatment of many patients who are critically ill. In certain cases more liberal drainage by open thoracotomy subsequently may be required, while in others the initial procedure may prove curative.

A rather considerable number of cases of pleural infection, especially among children, are characterized by the rapid outpouring of a large quantity of infected fluid which not only compresses the underlying lung but also displaces the heart and mediastinal structures toward the opposite side and thereby compresses the contralateral normal lung. Such a situation usually results in extreme respiratory and circulatory embarrassment to which pro-

found intoxication is often added as the result of septic absorption from the large, tense, collection of infected fluid. If the pulmonary inflammatory process, from which the pleural infection originally was derived, is still active, another complicating factor is present. Such a situation is frequently encountered in children suffering from so-called "synpneumonic" empyema. In cases of this type, the infection often begins within a few days after the onset of pneumonia and the latter may be at its height when widespread, pleural infection supervenes. In children also, necrosuppurative bronchopneumonic lesions often perforate into the pleura and produce pyopneumothorax rather than empyema (pyothorax). If the pulmonary perforation is of large size and a free communication between the lung and pleura results, substantial quantities of air enter the empyema cavity. This usually produces an extreme degree of pulmonary compression and mediastinal displacement.

In cases of the types just described, relief of symptoms is required promptly. Because of the fact that the purulent effusion is thin at an early stage of pleural infection, it is safe to assume that the effusion contains comparatively little fibrin and, therefore, the mediastinum is not well fixed by fibrinous exudate upon its surface. For this reason, "open" thoracotomy is contraindicated and the procedure usually advocated is repeated aspiration until such time as the fluid becomes sufficiently thick to render open thoracotomy safe. This usually requires from seven to ten days.

The utilization of repeated pleural aspiration to tide the patient over the critical period has a number of serious disadvantages which include the following: (1) Drainage is not continuous but is inter-



mittent. (2) In certain types of pleural infection, notably that due to the hemolytic streptococcus, the re-accumulation of fluid is so rapid that aspiration may be required several times a day in order to keep the symptoms under control. (3) Repeated punctures, especially when the pleural infection is of the streptococcic variety, may result in serious phlegmonous infection of the chest wall. (4) Repeated incomplete emptying of the empyema cavity by aspiration may result in irregular expansion of the lung, thus converting a single, large, empyema cavity into a series of smaller loculations. This not only may render subsequent surgery more likely, but often renders such surgery difficult and the results less satisfactory. (5) Repeated aspirations are distressing to the patient (especially if a child). (6) If tense pyopneumothorax, due to the free entry of air into the empyema cavity is present, aspiration has only very transient effects.

Stab thoracotomy combined with "air-tight" drainage is a procedure which is free from all these objections. It permits the continuous escape of the contents of the empyema cavity. Furthermore, by preventing the entry of air into the chest through the drainage tube, it permits return of the displaced heart and mediastinum to their normal positions, prevents their further abnormal mobility and facilitates re-expansion of the lung. Thus, respiratory and circulatory embarrassment and intoxication are rapidly, effectively and continuously combatted by means of a single, minor procedure which can be performed within a few minutes.

In other cases, a large purulent effusion may have developed comparatively slowly and diagnostic aspiration may have disclosed pus sufficiently thick to permit major thoracotomy without fear of undue mediastinal mobility. In such cases, however, the sudden release of a large, tense collection of pus by rib resection and the actual trauma of a procedure of such magnitude may produce an alarming "shock-like" state, especially if the patient is toxic

or debilitated. Stab thoracotomy is well suited to such cases for two reasons, first, because it is not a shocking procedure, and second, because the rate of decompression can be regulated through the use of an adjustable clamp applied to the drainage tube. In such cases, the end of the drainage tube may be left open and "air-tight" drainage dispensed with. In addition it is the custom of some surgeons to combine this type of drainage with certain forms of irrigation of the empyema cavity; and if the infection is controlled thereby, subsequent major thoracotomy may prove unnecessary.

Stab thoracotomy with "air-tight" drainage is contraindicated for obvious reasons in cases of empyema in which single or multiple, small encapsulations are present. Another contraindication exists in cases of anaerobic pleural infection resulting from the perforation of a putrid pulmonary abscess. Such pleural infections usually are serious and often fatal. The cardinal principle of treatment is to provide free aeration without delay in order to combat the virulent anaerobic infection. Personal experience has indicated that for this purpose stab thoracotomy seldom is adequate and that wide thoracotomy with free rib resection is the procedure of choice.

#### PROCEDURE

Although the use of a number of devices, including special cannulae and drainage tubes, has been recommended in stab thoracotomy, the procedure can be performed readily with the usual instruments. In order to secure dependent drainage the operative approach is made near the lower limit of the purulent collection. The instruments required are a syringe for the administration of local anesthesia, a few small, sharp-pointed, artery forceps and a scalpel. The remaining equipment consists of a moderately firm rubber drainage tube (about 10 or 12 inches long with a lumen  $\frac{1}{4}$  to  $\frac{3}{8}$  inch in diameter), a glass connecting tube, 3 feet of conducting tubing and a 1,000 cc. collecting bottle filled with water

to a depth of several inches. The distal end of the conducting tube is placed about 1 inch below the level of the water in the collecting bottle and is fixed to the neck of the bottle by adhesive straps. This prevents the end of the tube from being accidentally withdrawn from the water which forms a one-way valve permitting pus to escape from the tube but preventing the entry of air into the latter. The proximal end of the conducting tube is attached to the distal end of the drainage tube by means of the glass connecting tube. The drainage tube is prepared by clamping off the distal end close to the glass connecting piece. The proximal end is cut on the bias and a side opening made about 1 inch from the tip. A rubber collar, made of a short section of slightly larger sized rubber tubing, is slipped over the drainage tube and placed at a distance of 2 to 3 inches from the tip, depending on the thickness of the patient's thoracic wall and overlying tissues. The assembled unit is then ready for use.

The skin, subcutaneous tissues and intercostal muscles are injected thoroughly with  $\frac{1}{2}$  per cent novocaine at the site previously selected. Care is taken to inject all the tissues down to and including the parietal pleura. An incision about  $\frac{1}{2}$  inch long is made through the skin and subcutaneous tissues and partially through the intercostal muscles. The proximal end of the drainage tube is grasped with a small, sharp-pointed, artery forceps in such a manner that the tip of the clamp projects about  $\frac{1}{4}$  inch distally to the tip of the tube.

The tip of the artery forceps which grasps the tube is introduced into the operative incision and then is gently but firmly forced through the deep (uncut) layer of intercostal muscles and pleura into the empyema cavity. The tube is firmly held in situ with the free hand, while the artery forceps is unclamped and withdrawn. The drainage tube is fixed in place by passing several safety pins through the collar and strapping them securely to the skin with numerous strips of adhesive tape which pass over them in various directions. The artery forceps applied to the distal end of the tube, finally is unclamped and the contents of the empyema cavity permitted to drain into the collecting bottle which is placed on the floor at the bedside. An artery forceps is always kept at the bedside in order to clamp off the collecting tube whenever the distal end of the latter has to be removed from beneath the water in order to empty the bottle. The only other precaution to be observed is never to raise the collecting bottle to the level of the patient unless the tube is clamped off. Failure to observe this rule may result in the passage of fluid from the bottle into the chest should the patient cough or take an unexpectedly deep breath.

Although various devices have been employed to regulate the degree of negativity within the empyema cavity and drainage system, we have found the simple apparatus described above to serve its purpose adequately. Furthermore, it requires practically no attention except to empty the collecting bottle once a day and to refill it partially with water.



# PENETRATING WOUNDS OF THE HEART

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**P**ENETRATING wounds of the heart are emergency cases, but in any emergency it is well to take thought of what to do before doing it. The complications of immediate importance are hemorrhage and pericardial tamponade. As little as 200 or 300 c.c. of blood may so distend the relatively inelastic pericardial sac that ventricular diastole cannot occur. By preventing ventricular filling pericardial tamponade prevents ventricular output into the general circulation, with arterial failure, cerebral anoxia, unconsciousness and collapse.

As the thoracic and mediastinal contents are held under a negative pressure the flow of blood in the venae cavae and right auricle, "the great venous gateway to the heart," is under a sucking pressure estimated to equal about 8 to 10 cm. of water. When the positive pressure upon the heart from pericardial tamponade equals or overcomes this, the circulation comes to a standstill until the venous engorgement outside the thorax builds up sufficient pressure to force blood into the heart again. If the elastic recoil of the lungs is not lessened by pneumothorax the circulation may be maintained for some time longer. But eventually this mechanism fails and death ensues.

Whether the symptoms of collapse are due to shock or to hemorrhage and tamponade is an important matter. Loss of blood from the general circulation calls for suitable fluids. Every office should be equipped with bottles of sterile normal salt solution, 5 per cent dextrose and possibly a suitable acacia solution. These may be obtained with sterile-pack tubing and needles from several pharmaceutical supply houses. Experience shows that intravenous infusion in these cases seldom does harm and may be life saving.

Exact differential diagnosis may be difficult and preparation for operation should be instituted at once. If the entrance wound has produced pneumothorax the local heart signs may be obscured. Fluoroscopic examination, if quickly available, is of assistance in diagnosing tamponade as the heart shadow is enlarged and the heart excursions lessened. Rapid pulse, air hunger and restlessness on the part of the patient suggest hemorrhage, while a low arterial pressure, faint or absent pulse, "quiet" heart and unconsciousness suggest tamponade. However, free bleeding into the pleural space may divert so much blood from the brain that syncope may result. Wounds in the ventricles bleed more furiously because of the increased pumping pressure and are more likely to fill the pericardium. Wounds in the auricles, unless large, bleed more slowly and are less likely to strip loose the pericardium and produce tamponade. Blood may be lost into the pleural space instead.

Bigger<sup>1</sup> divides heart wounds into four groups: (1) those with slight or moderate bleeding in which the wounds communicate freely with the pleura. They are treated conservatively. In group 2 are patients with tamponade who improve after fluid infusion, adrenalin and morphine. These patients are prepared for operation. While this is being done a cannula is inserted into the pericardium to determine the pressure and if possible to remove some of the blood, relieve the tamponade and allow better heart action. The cannula is left in for fifteen to thirty minutes and if bleeding recurs operation is done at once. Group 3 includes those cases with severe tamponade and low arterial pressure, which do not respond to conservative measures. They should be operated upon without delay, pericardial aspiration being done mean-

while. Group 4 includes patients with free communication with the pleura and massive hemorrhage. They should be operated

If the entrance wound indicates injury to the lung a transpleural approach permits examination and treatment as well as re-

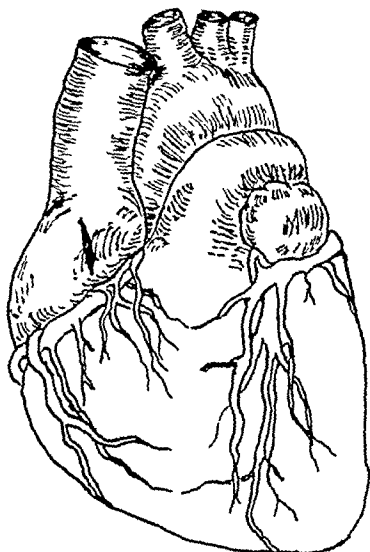


FIG. 1. Location of stab wound in right auricle.

upon at once and the blood reinfused while attempts are made to control the hemorrhage. Bigger remarks that few patients with this type of injury survive sufficiently long to secure surgical aid.

Briefly, the things to be noted immediately upon seeing a patient with a heart injury are: (1) character of the pulse (present, absent, fast, slow); (2) character of the heart action ("quiet" in tamponade); (3) quality of the arterial pressure; (4) color and demeanor of the patient (restless in hemorrhage, quiet in tamponade; ashy color in tamponade; pale in hemorrhage).

Things to do: (1) administer saline or acacia infusion if indicated; (2) give adrenalin or neosynephrin to maintain arterial pressure; (3) morphine if restless. Prepare field for operation.

*Operative Treatment.* Several incisions have been described in texts and Elkin<sup>2</sup> has pointed out the advantages of various incisions, especially the transverse incision separating the pectoral fibers with rib resection beneath the retracted muscle. Any approach which is time consuming, shocking, or which involves bulky instruments such as rib spreaders, should be avoided.

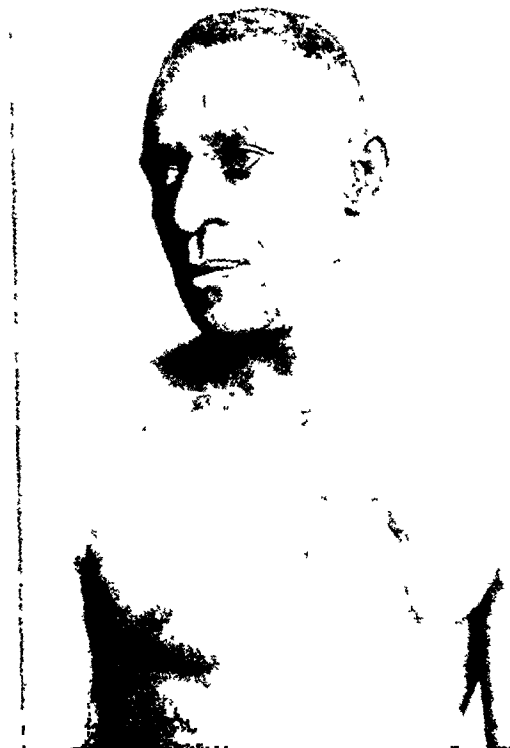


FIG. 2. Postoperative appearance of patient.

moval of blood from the pleural space. If pericardial tamponade is present, exposure must be adequate to allow control of the wound which bleeds freely when release of the tamponade allows the circulation to become active again. If a transpleural approach is made the collapsed lung flaps about with respirations and voluminous gauze packing is necessary to control undue movement during operation.

General anesthesia is probably best because with the release of tamponade, improvement of the circulation and partial return of consciousness, these patients become unruly. The pleural reflex induced by the necessary manipulations and open pneumothorax would be troublesome were local anesthesia used. If an anesthesia apparatus is used some positive pressure may be exerted upon the collapsed lung and the administration of oxygen and carbon dioxide may be carried out when indicated.

## CASE REPORT

H. C., 36, colored male hotel porter, was stabbed in the left chest with a knife used for paring vegetables. The wound was approximately over the left third interspace about 4 cm. from the midline. He was brought to the office of one of us (T. P. W.) within half an hour. There was slight bleeding from the entrance wound, the pulse could not be felt at the wrist and the heart sounds were faint and rapid. The patient was quiet and unconscious.

Consultation was held at once and operation was done as soon as the patient could be removed to a hospital. Under light ether anesthesia a window opening was made by cutting the third, fourth and fifth ribs with a shear and the costal cartilages with a knife, the skin and muscle having been reflected. There was a wound in the lung which was not bleeding, as the lung was collapsed. The heart was well exposed and a half inch wound found in the right auricle. (Figs. 1 and 2.) There was a steady stream of blood flowing from the wound and a large amount of blood, mostly clotted, in the left pleural space. The movements of the heart and lungs became tumultuous following the administration of epinephrine and production of pneumothorax. The lung movements were partly controlled by packing gauze about the lung. A finger laid over the wound in the auricle controlled the bleeding while fine silk sutures were passed and tied. The pericardial wound was but slightly larger than that in the auricle and was also closed with silk sutures. There was no tamponade. Blood clots were scooped from the chest with the hand and the remainder of the blood removed by sponging.

The wound was closed in layers and a small rubber drain put in. Morphine and fluids were administered as necessary. The patient did well until signs and symptoms of empyema developed at the end of two weeks. The empyema was drained through a stab wound and when this healed without undue complications the patient was discharged in good condition and returned to his work. Operation was done on March 12, 1938. The patient has remained in good condition.

## CONCLUSIONS

That death did not occur from hemorrhage seems due to the fact that the pressure in the auricle was comparatively low. There was a much diminished cardiac output because of the break in continuity of the blood stream passing through the heart chambers, the loss of blood from the auricle, and a disturbance in the sucking pressure normally exerted upon the venous gateway to the heart. This last doubtless allowed a damming back of blood in the venous system so that the patient suffered from both hemorrhage and relative cerebral anoxia. This case illustrates the wisdom of prompt operation even though the prognosis seems hopeless.

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# OPERATIONS ON THE PHRENIC NERVE

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**S**URGICAL procedures performed upon the phrenic nerve are always for the purpose of paralyzing the corresponding hemidiaphragm. The type of operation performed is dependent upon the length of time for which paralysis is desired. This in turn is dependent upon the indications for the procedure.

*Indications.* Paralysis of a hemidiaphragm or occasionally of the entire diaphragm is desired in a variety of conditions. The use of the procedure in the treatment of pulmonary tuberculosis was widespread during the decade from 1925 to 1935. In recent years, the indications have narrowed considerably and today its use is exceedingly limited. Table 1 cites some of the more common usages for diaphragmatic paralysis. It is not the purpose of this paper to discuss the indications and contraindications for the procedure. For such information, reference must be made to standard works upon the subject.

*Anatomy.* The phrenic nerve arises from the fourth cervical nerve, usually receives branches from the fifth and occasionally from the third, and passes around the lateral border of the scalenus anticus muscle. It crosses the anterior surface of this muscle from without inward, deep to the transverse cervical vessels, passes along its mesial border behind the clavicle and between the subclavian artery and vein into the thorax. Within the thorax, it passes downward through the middle mediastinum alongside the pericardium to the diaphragm, where it divides into branches supplying the various parts of this muscle.

The variations in the origin of the phrenic nerve are of great importance in its surgery. The percentage of cases in which it arises from more than one cervical nerve is so great that these branches must be looked

for and cut if one is to expect a complete paralysis. The most common accessory branch is from the fifth cervical root, which should always be carefully examined if complete avulsion of the nerve is not performed. Unilateral, double, triple and even quintuple nerves have been described, as well as slings around the internal mammary, transverse cervical and subclavian vessels. The nerve has even been described as passing through the subclavian vein, or buried in its wall. Fortunately, most of the accessories are not too intimately connected with blood vessels and join the main trunk within a distance of 11 to 13 cm. from the level at which it crosses the scalenus anticus. Therefore, if avulsion of the nerve is performed and at least 13 cm. are removed, one may be confident that a total and permanent paralysis of the hemidiaphragm will ensue. Anastomoses with the subclavian and suprascapular nerves as well as the ansa hypoglossi have been described.

The phrenic nerve may cross the scalenus anticus muscle in an almost horizontal position either high up near its origin or low down near the clavicle. If not found in its usual position, it should be sought laterally near the cervical plexus or medially between the medial border of the muscle and the internal jugular vein. The size of the main nerve is a fair indication of the presence or absence of important accessories; a small phrenic nerve usually indicates large accessories.

The phrenic nerve is the sole motor nerve to its corresponding hemidiaphragm. Interruption of its nerve impulses causes immediate paralysis of the muscle with atrophy which begins in a few weeks and progresses until it becomes complete about the third or fourth month. Paralysis of the

diaphragm is usually accompanied by an elevation in its position and by paradoxical motion, i.e., it descends during expiration and rises during inspiration.

be used; any anesthesia which does not provide for the return of consciousness within a few minutes after the conclusion of the operation should be avoided.

TABLE I

## INDICATIONS FOR DIAPHRAGMATIC PARALYSIS

Treatment of Pulmonary Tuberculosis	As an Independent Procedure	In early cases as aid to bed rest; for small, fresh, thin-walled cavities; for cavities near hilus or in lower lobe; for hemoptysis; for pain from diaphragmatic adhesions; to aid in reexpansion of lung in presence of pleural infection.
	As Aid to Other Collapse Procedures	In some types of ineffectual pneumothorax; at discontinuation of pneumothorax; to aid in closing empyema cavities in conjunction with thoracoplasty; in conjunction with scalenotomy or anterolateral thoracoplasty (Monaldi); in conjunction with intercostal neurectomy or pneumoperitoneum.
Treatment of Nontuberculous Diseases	As Aid in Major Thoracic Operations	Pneumonectomy, lobectomy, herniation and wounds of diaphragm, etc. (Nerve exposed within the thorax.)
	Spasm of Tetanus, Encephalitic Tic, Intractable Hiccough	
	Diaphragmatic Hernia	Small para-esophageal type Large hernia in which operation is contraindicated
	Bronchiectasis, Lung Abscess, Pulmonary Suppuration	
	Hemoptysis	
	Basal Empyema Cavities	
	To Increase Volume of Abdominal Cavity before Operations for Huge Scrotal or Umbilical Hernias	

TABLE II

## TYPES OF OPERATIONS

Transient Paralysis—Novocaine Injection		Without skin incision Nerve exposed
Temporary Paralysis	1-3 Months—Freezing with Carbon Dioxide Snow or Ethyl Chloride	
	4-8 Months	Phrenemphraxis (crushing) Alcohol Injection Simply Phrenicotomy (cutting with approximations of ends)
	10-12 Months—Crushing with Partial Extraction (Frank)	
Permanent Paralysis	Phrenicectomy (phrenic neurectomy-avulsion)	
	Radical Phrenicotomy (Goetze)	

*Types of Operation.* The various types of operations which may be performed upon the phrenic nerve in order to obtain a paralysis of the diaphragm are given in Table II. It must be remembered that in a small percentage of "temporary paralysis" procedures, a permanent paralysis may occur; likewise a small number of "permanently paralyzed" diaphragms may have return of function.

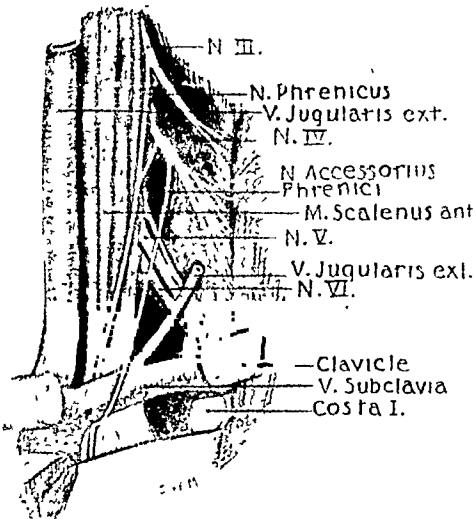
## TECHNIC

The patient lies on his back with a small pillow under the shoulders in order to extend the neck slightly. In patients with copious sputum, a moderate Trendelenburg position should be used. The head is kept in the midline but turned away from the side to be operated upon. Local infiltration is the anesthesia of choice. In children who cannot be controlled, a light narcosis may

After ordinary skin antisepsis, the field of operation is draped, leaving the nose and mouth free. The posterior border of the clavicular portion of the sternomastoid muscle is found by having the patient raise his head. If possible, the course of the external jugular vein is noted. The incision should lie between these two landmarks and be situated about 2 cm. above and parallel to the clavicle. Until the surgeon has performed a number of phrenic nerve operations, it is advisable for him to use a somewhat larger incision, extending it slightly mesially over the sternomastoid muscle and also more laterally. This may necessitate tying off the external jugular vein. The type of operation determines the length of the incision. For an avulsion, a smaller incision will suffice because there is usually no need to search for accessory branches. The above described incision is

the one most commonly used, although Lilienthal has advocated an incision upon the clavicle, and others have used a vertical

The deep layer of the deep cervical fascia covers the scalenus anticus and the nerve roots; and if the phrenic is in its normal

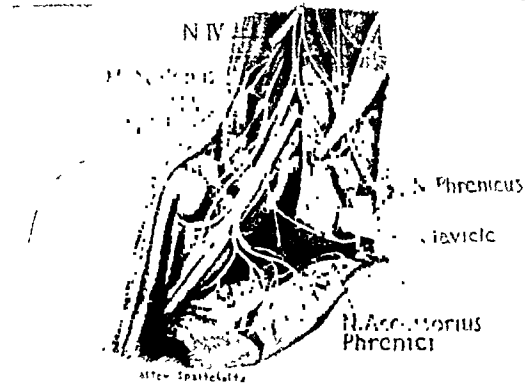


Accessory Ramus of Phrenic Nerve  
Type I.

FIG. 1. Accessory ramus of the phrenic nerve derived from the third or fourth cervical nerve and taking a vertical course. (*J. Thoracic Surg.*, 2: 538, 1933.)

incision along the lateral margin of the sternomastoid.

Only the skin and subcutaneous tissues need be anesthetized. Any deeper injections are dangerous due to the proximity of important structures. The incision should be placed in a natural skin crease and should be planned before the skin is distorted by novocaine injection. After incision of the skin, subcutaneous tissue, platysma muscle and superficial layer of the deep cervical fascia, the lateral border of the clavicular portion of the sternomastoid comes into view. When this is retracted medially, a fat pad overlying the scalenus anticus muscle is exposed. For safety, sharp pronged retractors should never be used. Delaney has designed a special phrenicectomy retractor for use in small incisions. The fat pad on the scalenus is either teased apart or separated by blunt dissection with Mayo scissors or hemostat. Beneath this layer of fat, the anterior surface of the scalenus anticus muscle will come into view with the brachial plexus lateral to it.



Accessory Ramus of Phrenic Nerve  
Type II

FIG. 2. Accessory ramus of the phrenic nerve derived from the fifth cervical nerve and taking a horizontal course. (*J. Thoracic Surg.*, 2: 538, 1933.)

position, it can be seen through this fascial layer, lying upon the anterior surface of the muscle. This layer of fascia is then incised and the nerve exposed. Its normal size is about that of the lead in a pencil. If a phrenicectomy is to be performed, no further dissection is necessary. The nerve is isolated and 1 per cent novocaine injected into its sheath. Complete anesthesia does not occur for about two minutes and no manipulation of the nerve should be done until it is absolutely painless. The nerve is grasped with a hemostat and sectioned as high as possible. Using a steady uniform force, the surgeon slowly winds the nerve around the forceps in windlass fashion. Washburn and Proctor have devised forceps with a flange at the end in order to prevent the nerve from slipping during the avulsion. If there is severe pain in the chest, the procedure is stopped for a few moments. It is advisable to apply a second forceps lower down to prevent retraction into the thorax should the nerve break. Suddenly, the thoracic attachments will give way and a varying length of nerve will be extracted. If 13 or more cm. are avulsed, no further operative procedure is necessary, because, ordinarily, the accessories



join the main trunk within this distance from the point of exposure. If, as occasionally occurs, a shorter piece has broken

phrenicotomy. (Goetze.) For the latter procedure, a slightly larger incision may be necessary. The nerve is followed to both

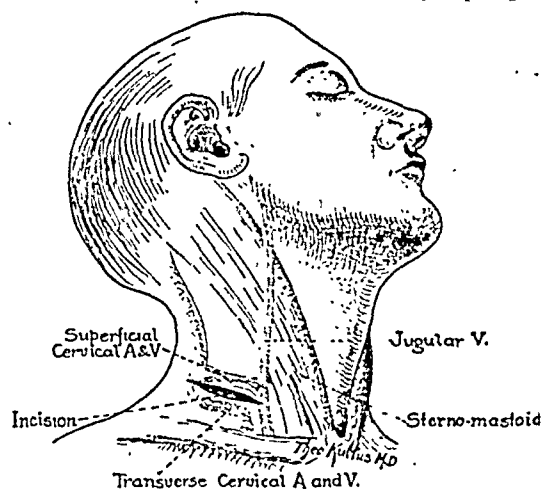


FIG. 3. Site of incision through the skin showing relations to deeper structures. (*Illinois M. J.*, August, 1932.)

off, it is advisable to search for accessory nerves and resect them.

If the phrenic nerve is not found in its usual position, crossing the scalenus anticus, it must be searched for along the lateral or medial border of this muscle. When exposing the internal border, care must be taken to avoid injury to the internal jugular vein and the vagus or cervical sympathetic nerves. The phrenic nerve may be best identified by tracing it upward to its point of origin from its cervical nerve root. Pinching of the phrenic nerve will usually elicit pain in the anterior part of the shoulder. Broga has advocated electrical stimulation which will produce a hiccup or a prolonged inspiration.

If the phrenic nerve is not found either on the anterior surface or medial side of the anticus, it should be sought along the lateral edge where it must be differentiated from cervical and brachial plexus nerves. If not identified in any of these locations, the fibers of the scalenus anticus muscle should be separated, for the phrenic nerve has rarely been found in the muscle bundle.

When the phrenic nerve has been definitely identified and a permanent paralysis is desired, either an avulsion, as previously described, is performed, or a radical

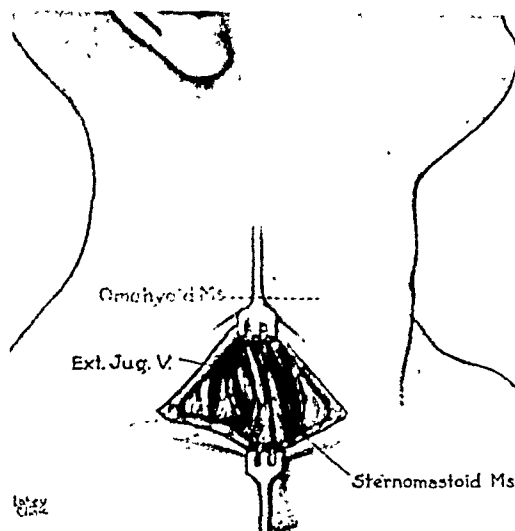


FIG. 4. Skin edges retracted showing sternomastoid and external jugular vein. (*Surg. Clin. N. America*, December, 1935.)

ends of the exposed area and any filaments or branches joining it are severed. The fifth cervical nerve should be exposed, and an accessory nerve running from it to join the phrenic nerve lower down should be sought. If found, this branch should be removed and then at least 2 to 3 cm. of the main phrenic nerve resected. This method, as advocated by Goetze, will give as high a percentage of effective permanent paralyses as phrenicectomy, with less hazards.

If only temporary paralysis is desired, the nerve is isolated from the surrounding tissues by packings, anesthetized and either thoroughly injected with absolute alcohol for a distance of 2 to 3 cm. or frozen with ethyl chloride or carbon dioxide snow. In order to assure a complete paralysis, the accessories should be exposed and resected, as in the Goetze method.

When simply phrenicotomy is done, the nerve is anesthetized, cut across and the ends approximated with fine silk sutures. When phrenemphraxis (crushing) is performed, at least 1 cm. of nerve should be crushed and care must be taken that all the nerve fibers have been caught in the serrations of the instrument. Special crushing forceps have been devised with the

serrations so arranged that complete crushing will result. With both phrenemphraxis and phrenicotomy, the accessories must be

Patients with large amounts of sputum from disease of the lower lobe may be suffocated immediately after operation by

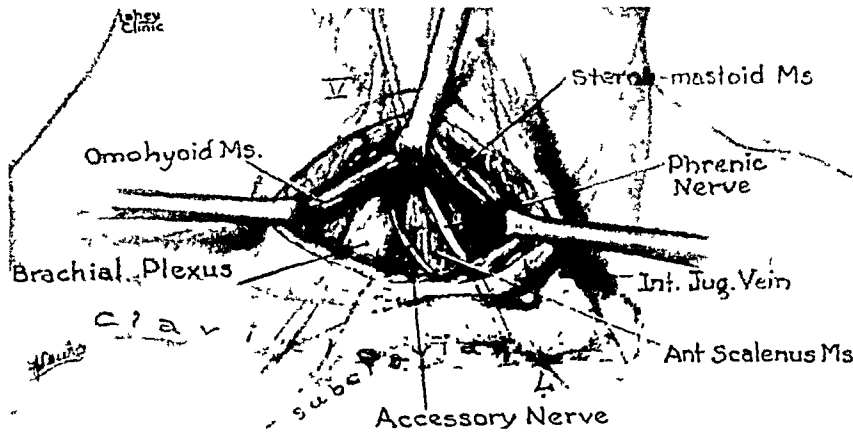


FIG. 5. Exposure of the phrenic nerve below the omohyoid muscle. (*Surg. Clin. N. America*, December, 1935.)

divided to insure complete diaphragmatic paralysis.

Some advocate tying a piece of fine silk loosely around the nerve and attaching this suture to the platysma in the wound. This may aid in locating the nerve, should a secondary operation be required. On the other hand, if the exact position of the nerve is described in the operative report, it is not difficult to find the nerve at a second or third operation.

Closure of the wound is simple: a few fine catgut sutures to the platysma, and either fine silk or clips to the skin. A subcuticular suture may be used if desired. If the incision has been placed in a natural skin crease, it will soon be practically invisible.

**Complications.** A survey of the anatomy of the operative area involved will give a strong hint as to the complications which may occur at the time of operation. Injuries to every structure in the region have been reported: tears of the internal or external jugular veins, with air emboli; hemorrhage from subclavian vessels, injuries to brachial plexus, cervical sympathetic and recurrent laryngeal nerves and thoracic duct. During avulsion, pleural tears may occur, as well as hemorrhage from the pericardiophrenic artery or vessels which have been encircled by accessory nerves.

the expulsion of these secretions into the bronchial tree. Those with diminished respiratory surface may have marked

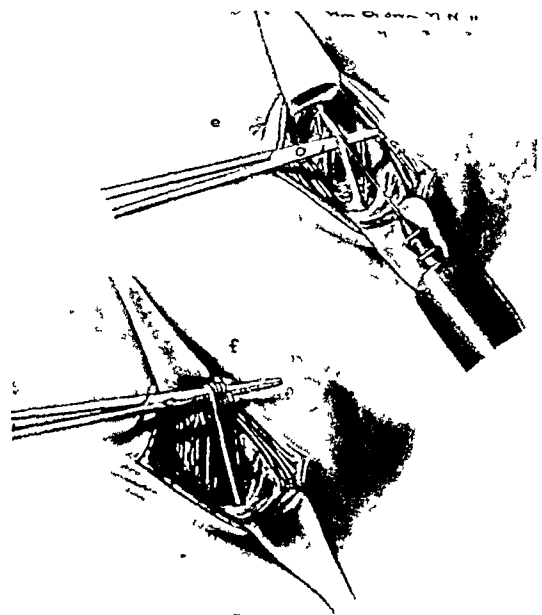


FIG. 6. e, method for infiltrating the nerve before avulsing or cutting it. f, technic of avulsion. (*Surg. Clin. N. America*, 12, 1579, 1932.)

dyspnea due to pressure of an elevated diaphragm upon the lower lobe plus absence of the normal diaphragmatic movement.

Left-sided paralysis may be followed by gastrointestinal symptoms due to displacement of the stomach, duodenum and large colon. Cardiac symptoms have been

observed because of mediastinal displacement. In decompensated cardiac states, paralysis of the right side of the diaphragm may interfere greatly with the return of venous blood to the heart.

**Tests for Diaphragmatic Paralysis.** It is advisable to determine shortly after operation whether the procedure has been successful in paralyzing the diaphragm. This must be done by fluoroscopy. The elevation of the hemidiaphragm may not occur at once. Diaphragmatic movement on the operated side may be entirely absent or it may be paradoxical, i.e., downward upon expiration and upward upon inspiration. This may be accentuated by the Bittendorf test. With the lips and nostrils tightly closed, the patient is instructed to inspire deeply. This causes a marked increase in the negative intrathoracic pressure and results in an exaggerated paradoxical rise of the flaccid hemidiaphragm.

When a pleural effusion or marked pleural thickening is present, the diaphragm may not be clearly visualized. Under these circumstances it may not be possible to determine definitely whether paralysis has been achieved.

Although the exposure of the phrenic nerve in the cervical region may be classed as a minor operative procedure, nevertheless, it should not be attempted by anyone but a qualified surgeon. The field of operation contains many important structures whose injury may lead to serious complications. A thorough knowledge of both the normal anatomy of the region and the variations which may occur is necessary. If this knowledge is combined with good surgical technic and careful anatomic dissection, complications will be minimized and good operative results obtained.

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# A NEW TREATMENT OF GANGLION

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FOR many years the treatment of ganglion has gone on unchanged, receiving as a rule, a non-surgical handling with no assurance the condition would not readily recur. Surgical removal has offered a difficult and hazardous procedure for such a benign condition.

A ganglion is a cystic formation which occurs on the capsular ligament of an extremity. It may follow strains and injuries and is most commonly found on the dorsal surface of the wrist but may be found about any articular surface. (At one time ganglia were supposed to be hernias of the synovial sheaths.)

*Pathology.* Sections show that these cysts develop within the capsular ligament and not in the sheath. An obliterative endarteritis of traumatic origin is the cause of the nutritional disturbances which precede the degenerative changes. At first several small cysts occur which later unite and form a larger one. They usually communicate with the articular surface.

*Diagnosis.* The localized swelling may be the only symptom, or weakness of the joint and in some instances quite severe neuralgic pains may be associated. The swellings are so characteristic in appearance that there is usually no difficulty in making a diagnosis. Lipomas, fibromas, gliomas, encapsulated foreign bodies, fragmented fractures and myositis ossificans may offer differential diagnostic problems.

*Treatment.* Previously treatment has consisted largely of rupturing the cyst by external force while the part was tense. Complete dissection is difficult and recurrence often occurs. The dangers of entering a joint for such a benign tumor are excessive. The injection of strong sclerosing fluids is dangerous and has largely been abandoned.

The new treatment consists of injecting a proteolytic enzyme (caroid) into the cyst and allowing this substance to remain within the cyst for several minutes. This enzyme liquefies the gelatinous material which can then be freely aspirated.

*Technique.* The skin is prepared surgically. Novocaine may be used to infiltrate the skin over the ganglion, but this is not essential if a sharp needle is used.

The solution used is a suspension of pulverized enzyme (caroid) in sterile distilled water, 1 dram of enzyme to each 5 c.c. of distilled water. One minim of hydrochloric acid is added to each 10 c.c. of suspension. This mixture is shaken vigorously and drawn into a 10 c.c. syringe fitted with a 20 gauge needle.

The ganglion is tensed, the needle inserted and under steady pressure the suspension is injected slowly into the ganglion. About three minutes should be used in injecting each c.c. Usually 2 c.c. of the suspension is sufficient, but this, of course, depends on the size of the ganglion.

In thirty minutes liquefaction is completed. However, the solution may be allowed to remain twenty-four hours without causing any distress and the patient may return the following day for aspiration. The ganglion may then be aspirated freely and the collapsed cyst irrigated with distilled water without removing the needle. A light pressure dressing is applied.

It has been found that this suspension also tends to destroy the secretory action of the walls of the ganglion so that recurrence is rare. However, if desired, a few drops of a solution of 10 per cent sodium morrhuate may be injected into the ganglion to act as a sclerosing agent.

A mild reaction may be evidenced by a slight stiffness and soreness, but these have

proved of mild nature and disappear in twenty-four to forty-eight hours. Hot applications alleviate this mild condition. No other complication has occurred.

#### SUMMARY

Previous methods of treating ganglia have been unsatisfactory or of undue risk

because of the difficulty of excising the cyst completely. A new method of treatment is presented based upon the proteolytic liquefaction of the gelatinous substance contained within the ganglion and its subsequent aspiration. This method is practical, atraumatic, and is a simple and safe procedure.



A GANGLION is the term given to a localized cyst-like swelling forming in connection with a tendon sheath or joint. . . . It varies in size considerably, and contains a clear, transparent, gelatinous or colloid substance. From—"Rose & Carless Manual of Surgery," Edited by William T. Coughlin (The Williams & Wilkins Company).

# POSTOPERATIVE CARE TO RESTORE NORMAL PHYSIOLOGY

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THE elimination of drastic preoperative purgation and starvation, except by a few of our older surgeons, has removed the discomfort to which the patient was previously subjected before operation. Developments in anesthesia and the judicious use of the opiates and barbiturates have rendered the apprehension and pain of the operative day practically non-existent. Postoperative comfort has also definitely improved, but even today, the patient fears the postoperative period with its gas pains, enemas, colonics, and its period of starvation.

While surgical resident in the American Hospital of Paris, I observed that most postoperative patients were more comfortable, did not become so distended and did not complain of gas pains so much, as patients previously observed in this country. The American Hospital patients on one surgical service (de Martel) after appendectomy were never given enemas. On the other service (Du Bouchet), enemas were not given before the third postoperative day. The comfort of these patients was very convincing and the benefits of restraint in the use of postoperative enemas obvious.

These experiences stimulated me to closer observation of the postoperative course and care of patients in an attempt to eliminate as much as possible the discomfort of the postoperative period.

The condition of the gastrointestinal tract following surgery is influenced by several quite variable factors: (1) *The particular operation involved.* A pelvic operation is not so shocking to the patient as an operation involving the gastrointestinal tract; a simple appendectomy not so severe as the removal of a gangrenous appendix. (2) *The surgeon himself.* One surgeon will

produce twice as much trauma as another in doing exactly the same operation. (3) *The patient.* A young robust patient has far more resistance than an aged debilitated patient.

The definite pathologic physiology in the gastrointestinal tract following operation is as variable as the sum total of these three and other mutable factors. There is a noticeable reaction to every surgical operation, even with ideal conditions. The effect of trauma during operation is not localized to the area of the gut involved in the operation but affects the entire gastrointestinal tract. This all or none principle of the intestinal tract probably functions by way of the myenteric plexus. The trauma of operation through the sympathetic system causes an inhibition of the peristaltic movements of the wall of the gut and diminution of its tone along with a tight closing of the sphincters. All the normal gastrointestinal secretions are inhibited as the result of the anesthesia and the surgical procedure carried out.

It would seem that the ideal postoperative care would be that which would lead to a restoration of the normal physiology in the shortest time possible. Withholding food from these patients for three or four days certainly does not help, for it adds starvation to an already damaged body. The repeated administration of enemas to a patient who is not in condition to use his voluntary muscles to help expel them and whose intestinal peristalsis is inhibited and gut wall relaxed and already empty, is not physiologically helpful but actually abusive. This line of procedure increases the fertility of an already ideal field for the multiplication and proliferation of the bacterial flora normally found in the lower intestinal tract with associated gas forma-

tion. I feel that the usual postoperative care does not aid in the restoration of normal physiology but adds starvation, abuse, and increases gas formation in an already disturbed physiologic state and prolongs postoperative recovery.

For the past four years I have as a general rule followed a postoperative plan quite different from that usually encountered. The basic features of this plan are: (1) early feeding; (2) elimination or late use of enemas; and (3) early bed activity of the patient.

Reversed peristalsis and, occasionally, vomiting have been observed in the empty gastrointestinal tract of a normal person. One would expect that nausea and vomiting would be more frequent with the effects of the trauma of an operation added to the existence of an already empty intestinal tract. I believe that lack of food in the stomach has a definite bearing in some cases of postoperative vomiting. Thomas<sup>1</sup> has observed that vomiting in dogs which had been operated upon often stopped after they were fed a normal meal. I have seen numerous cases where postoperative vomiting stopped promptly after the patient had taken some solid food. No physiologic reason has been discovered that would render postoperative feeding harmful, provided the food is retained and there is no specific contraindication such as definite operative interference on the gastrointestinal tract.

It is an established fact that food is the normal and best stimulant for the promotion of gastrointestinal secretions. These gastrointestinal secretions are the normal inhibitors of the growth of bacterial flora and, together with the mechanical action of the food, are the stimuli of normal peristalsis.

I, therefore, feed my patients solid food as soon as they are able to take it and retain it. Variable factors involved in various operations exert their influence, but practically every patient is given a tray of soft food the morning following

operation. If he has recovered from nausea and vomiting after anesthesia, he is given food the evening of the day of operation. It is not expected that the patient will eat everything on the tray; most do not. If they eat a small amount, when time for the next tray comes around they will eat a little more and by the time the third or fourth postoperative day arrives these patients are consuming everything on the tray, with comfort and enjoyment, while the patient under the usual routine is uncomfortable and attempting to eat a bite or two from his first tray of solid food.

The soft food which is given the patient is the routine hospital tray usually made up from the following list of foods:

1. Cereals
2. Eggs
3. White meat of chicken
4. Bread or toast
5. Strained fruit
6. Macaroni
7. Baked or mashed potato
8. Sponge cake or vanilla wafers
9. Butter
10. Cream and cottage cheese
11. Eggnog
12. Custards
13. Soft deserts
14. Milk is not withheld

If a patient is able to take food the day of operation, he is usually given toast and jelly, cereal, junket, or ice cream. Occasionally, a patient fed the day of operation will vomit during the latter part of the evening, but as a rule very little, if any, of the food is discovered in the vomitus and in the morning he will eat willingly.

The occasional patient, usually a frail neurotic female, who will be found still vomiting or more likely gagging and retching twenty-four hours or more postoperatively and abhorring the thoughts of food, can be persuaded to eat a little ice cream. I have seen gagging stop almost miraculously after ice cream and the patients proceed to the soft food stage without further difficulty.

<sup>1</sup>THOMAS, J. E. Personal communication.



Patients who have had partial gastrectomies or gastroenterostomies may have Levine tubes passed before closure of the abdomen. The operator can see that it is threaded 6 or 8 inches beyond the operative site and the patient can be fed predigested mixtures through the tube. It is often possible to give these patients enough liquid nourishment by way of the tube to maintain their water balance and thus avoid the use of intravenous infusions.

Patients fed early after operation are remarkably free from gas pains and distention. The degree to which they suffer from gas pains and distention on this routine depends to a great extent on the variable factors which we have previously mentioned. Practically every patient has some gas pains. Minor distention is not infrequent, but serious distention is rare. As a rule these conditions are at their worst about twenty-four to thirty-six hours after operation. If at this time the patient is not able to pass gas rectally of his own accord, a rectal tube is inserted and, in from four to eight hours, gas pains and distention disappear.

No further attention need be paid to the bowels till they move or until the fourth or fifth postoperative day. At this time if the bowels have not moved it is my practice to instil 2 ounces of mineral oil and 2 ounces of glycerin into the rectum slowly through a catheter, and a bowel movement usually results promptly. I do not claim any special therapeutic value for this combination, but believe that its effect lies in the mechanical stimulation of the rectum through distention.

It is also part of my practice to administer 1 ounce of mineral oil by mouth twice a day beginning the second or third postoperative day. Mineral oil has a value as a lubricant and aids in keeping the stool soft. Some patients are upset by it, while with others it seems to pass through the intestinal tract with no effect except for the constant leakage and associated soiling of linen. Some of the agar-mineral oil emulsions with or without cascara or phenolphthalein are therefore often used

to better advantage. Regardless of the effects of these adjuvants in moving the bowels no direct attack is made on the bowel itself before the fourth or fifth postoperative day.

The third part of this plan consists in encouraging the patient to move about in bed as much as possible consistent with the pain caused by such movements. The more activity, the sooner the return to the normal physiologic status. Activity and use stimulate the normal physiologic functions while disuse encourages regression of functions.

Naturally the type of incision, the condition of the patient and the type of operation performed govern the question as to when the patient shall get out of bed. This question does not affect early bed activity. The patient is encouraged to roll from side to side in bed without the aid of a nurse, to use arms and legs freely and to take deep breathing exercises. Not only is early bed activity an aid in restoration of normal function, but the mechanical effect of activity helps to relieve the discomfort of postoperative gas pains.

#### CONCLUSIONS

This postoperative plan not only aids in a quicker restoration of normal physiologic function with a minimum of discomfort, but its effect on the patient is a major factor in the postoperative period. The mental attitude of any patient is often the barometer of his physical comfort. Patients receiving a liquid diet, which does not furnish enough calories for minimum basal requirements, and given repeated enemas and colonics, are often like a falling barometer, blowing up a mental storm which will tax the bedside manner of the ablest clinician. The mental attitude of patients fed solid food early and spared the increasing discomfort of repeated enemas presents the aspect of a rising barometer with bright and cheerful mental skies, which will also ease the mental strain of the attending surgeon.

I have found that the postoperative course of patients treated in this manner is

smoother and more comfortable and the morbidity period is shorter. Restraint has, however, been exercised in this presentation in an effort to set forth a logical analysis which it is hoped, will convince the reader of the advantages of this plan and encourage him to try it either in whole or in part.

#### SUMMARY

Customary postoperative care does not give the patient maximum comfort. Fac-

tors affecting the physiology of the gastrointestinal tract following operation, their modes of action, and their results are analyzed. Usual postoperative care aggravates the already impaired physiology. A plan of early feeding, restraint in the use of enemas, and early bed activity is outlined, which is helpful in restoring normal physiologic function.

The beneficial effects of this plan for both patient and surgeon make it worthy of trial.



POSTOPERATIVE retention of urine is a common inconvenience after operations in this region; subcutaneous injection of esnodil will often relieve it.

From—"Rose & Carless Manual of Surgery," Edited by William T. Coughlin (The Williams & Wilkins Company).

# LYMPHANGITIS AND LYMPHADENITIS\*

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## LYMPHANGITIS

THE name "lymphangitis" is commonly applied to that condition in which with some infection in the skin streaks of reddish or red and bluish discoloration are noted which extend along the extremity or part affected to the neighboring lymph nodes. Whether the term should be restricted to this type of infection only or to cellulitis as well may be a disputed question. Certainly in cases of cellulitis the local lymphatics are involved as they are in erysipelas and the erysipeloid infections. However, the name has been so commonly associated with that type of lesion described that we believe its identity as an entity should not be disturbed. One may see the condition associated with almost any type of infection of the extremities. A review of all cases seen at the Mayo Clinic during the years 1938 and 1939 reveals that a diagnosis of this condition was made in seventy-two cases during this period. The arm was involved in twenty-one cases and the leg was involved in fifty-one. In thirty-four of the fifty-one cases in which the lower extremity was involved trichophytosis was the most likely etiologic factor. This group of cases includes many in which the patients came to the Clinic on account of persistent swelling of one or both lower extremities and in many cases chronic lymphedema was developing. However, this condition is fairly frequently seen and so far as the development of chronic phases and persistent symptoms is concerned it probably is the most important of all types of lymphangitis.

Briefly, it should be recalled that the lymphatics are composed of a widespread network of capillaries which are found in the skin and subcutaneous tissues and

empty into the tubular lymphatics which carry the lymph through into larger lymphatic veins which pass along the larger blood vessels to the thoracic duct, and thus into the venous circulation through the thoracic duct and the right lymphatic duct. This system of lymph capillaries is composed of a single layer of endothelial cells bathed in tissue fluids. Actually, many organs of the body have lymphatics and lymph circulation, but for our purposes here only the lymphatics of the subcutaneous tissues will be considered.

Lymph is composed essentially of the same materials as blood plasma but in a more dilute form. The chemical composition and cellular content may, however, vary greatly in pathologic conditions. The cellular content is about 95 per cent lymphocytes. The lymph contains all foreign materials carried away from the tissues. These foreign substances are apparently taken up by phagocytes but may also be carried along in the lymph stream by mechanical means.

Two factors are responsible for the propulsion of lymph through the lymph vessels: (1) contractions of skeletal muscles, and (2) pulsations transmitted through the arterioles. Thus, an important factor in treatment may be rest because of the reduced flow of lymph owing to inactivity of the skeletal muscles.

In reviewing the etiologic factors aside from trichophytosis we found that in cases in which an arm was involved the inciting causes were as follows: laceration in six cases, infection in six cases, carcinoma of the breast (with edema of arm) in four cases, lesions secondary to vaccination in one case, dermatitis venenata in one case, paronychia in one case, bite on finger in one case and abscess in one case.

\* From the Section on Orthopedic Surgery, Mayo Clinic and Mayo Foundation.

The group of inciting lesions in the lower extremity were, as indicated previously, predominated by the trichophytosis but the following conditions also were noted: blisters on heel in two cases, stasis ulcer and cellulitis in two cases, compound fracture in one case, arthritis of ankle and other conditions less clearly associated with the lesion.

Unfortunately, for any statistical value, cultures of the lesion were made in only six of the seventy-two cases and of these three showed no growth, two showed streptococci and one revealed *Staphylococcus aureus*. It is the prevailing impression that streptococci are usually the causative agent in these cases although most authors recognize that other organisms may be the cause.

The usual story is that following some minor scratch or cut the patient notes a moderate local swelling with stinging pain and then a sense of malaise with chills. Often, within the first twenty-four hours, the red streaks develop and tender swollen axillary or inguinal lymph nodes are noted, although the latter usually are noted a few hours later. In our series of cases chills were noted in twenty-five, malaise in twenty-three, nausea in six and headaches in four. Pain of a varying degree is always present.

The rapidity of the onset and the severity of the symptoms together with the obvious local changes and the streaking are so obvious to the patient and relatives that medical aid is sought at once, and it is this picture that in the layman's mind often indicates a "blood poisoning." Hence the patients usually are willing to submit to the obviously necessary treatment.

The condition is associated in the minds of many with severe reaction and often fatal outcome, but death occurred in only one case in our series. In this case the patient was a man, aged 77 years, who had been bitten on the hand by an insect a few days previous to onset. Local cellulitis and lymphangitis developed from which staphylococci were grown. Death

in this case seemed to us to be due to senility and lack of resistance to a moderately severe infection. Blood cultures in this case were negative. In fact, no positive blood cultures were obtained in any of our cases of lymphangitis and it is our recollection that in spite of the often severe onset of the condition in many cases and the dramatically serious appearance of the patient, the response to adequate treatment is equally dramatic and subsidence of symptoms is fairly rapid under treatment properly carried out.

The end results in all but one of our cases were good. In many of the group of cases in which recurrent attacks of lymphangitis were associated with lymphedema, some permanent swelling was noted and this often had to be controlled by the wearing of rubber bandages and by elevation of the extremity for a period each day. In most of the cases in which the condition was acute and followed trauma, the condition responded satisfactorily and in most cases, quickly, to treatment.

Treatment in these cases should be undertaken only with the patient completely at rest in bed. As noted previously, much of the propulsive force behind lymph flow comes from the action of the skeletal muscles. With the patient and the affected part completely at rest, this force is reduced and the speed of lymph flow slowed down so that the spreading of infection is curbed. In addition it has been demonstrated by Drinker that the filtrative function of the regional lymph nodes is at its best with the part at rest. We usually apply hot or warm packs to the affected part and elevate the affected part. The hot packs are applied by wrapping the part in sterile, moist gauze and surrounding this with blankets wrung out of hot water and then surrounding the whole mass with a piece of oilcloth. These hot packs serve a dual purpose: (1) They furnish a penetrating heat, and (2) they act as a splint and prevent motion in the affected part. If an open wound exists, the

dressing next to the wound must, of course, be sterile. It is customary to cover the skin with a thin layer of petrolatum to prevent blistering, and care should always be taken to see that the dressing is not too hot. This is particularly important in cases in which the patients are unconscious or in cases in which there is some disturbance of sensation in the affected part.

In conjunction with the enforced rest and use of hot packs, it is important to give the patient plenty of fluid. Fluids should be by mouth or, if the patient is vomiting and cannot take them by mouth, 1000 cc. to 2000 cc. of physiologic saline solution should be given daily by the subcutaneous method. Sulfanilamide in doses of 80 to 120 grains (5.3 to 8 Gm.) per day should be administered and in many cases the use of roentgen therapy is beneficial. Light doses of roentgen rays in the early stages may do much to hasten the resolution of acute lymphangitis. We have observed subsidence within a very few hours after institution of such treatment.

In most cases the condition will subside within a few days with the combination of these therapeutic measures. Occasionally there may remain a region of cellulitis which results in an abscess which has to be drained, or occasionally a lymph node may suppurate and require drainage.

In some instances intolerance to sulfanilamide may be noted and its use must be discontinued. The usual precautions regarding blood counts and the concentration of sulfanilamide should be observed.

#### LYMPHADENITIS

The subject of lymphadenitis is a much more inclusive one than lymphangitis. In almost every instance of infection in an extremity, some degree of lymphadenitis may be found. It may be a very mild enlargement without pain or tenderness, as may be seen in any case of chronic low grade infection of the skin, such as a mild acneform infection. Indeed, regional lymphadenitis may be seen among persons whose skin is unclean and may be associ-

ated with such conditions as pediculosis. Besides all the variations of lymphadenitis, one sees chronic affections of the lymph nodes, such as tuberculosis, various types of granuloma, as well as numerous non-malignant diseases and malignant disease of lymph nodes, both epitheliomatous and sarcomatous.

Differential diagnosis in the acute types of lymphadenitis is, as a rule, not difficult. The suddenness of onset and the accompanying regional infection often accompanied by lymphadenitis are enough to produce the clinical picture unless adenitis has been present before the infection, which might confuse the picture.

In cases of subacute and chronic lymphadenitis, however, a much more difficult problem in diagnosis may present itself. In such cases one may be dealing with a chronic lymphadenitis of inflammatory nature, with one of the lymphatic diseases such as lymphoblastoma or Hodgkin's disease, with metastatic involvement of the lymph nodes by a neoplastic lesion. The latter condition may be complicated owing to the fact that neoplastic lesions in these cases are often the site of a secondary infection which may in turn be transplanted to the regional lymph nodes so that a purely metastatic infection may be superimposed on a metastatic neoplastic lesion.

Thus, the diagnosis may be difficult and biopsy of one of the affected lymph nodes may be the only means of making an accurate diagnosis. Indeed, at times, this, too, is of doubtful value because a definite pathologic picture may not be present or the lymph node removed may not contain the pathologic lesion but merely may be the site of an inflammatory reaction. However, on the whole, it has proved a very satisfactory method of settling the diagnosis in many doubtful cases.

Treatment of lymphadenitis varies according to the type and stage of the disease. In those cases in which acute lymphadenitis is associated with lymphangitis we have been accustomed to use an ice cap

or ice pack over the lymph nodes to prevent further spread of the infection. This treatment seems to have been effective in most instances. If local swelling persists and is followed by softening and fluctuation, indicating suppuration of the lymph nodes, surgical drainage is necessary. At times, persistent swelling without softening may be reduced by the use of roentgen therapy. Suppuration may thus be hastened or the absorption of the inflammatory mass may be hastened.

#### SUMMARY

In the various types of lymphatic disease the use of roentgen therapy is recognized

as the best type of treatment. In some cases the beneficial effects are only temporary and it is necessary to repeat the treatment from time to time. Many of these diseases are really neoplastic and in the long run their prognosis is uniformly bad.

Local metastatic lesions caused by malignant neoplasms may be treated by roentgen therapy as a palliative measure, but it must be recognized that the ultimate prognosis in such cases also is bad.

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# FURUNCLES AND CARBUNCLES: PREVENTION OF GENERAL POSTOPERATIVE INFECTION

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**A**N apparently trivial furuncle, treated by incision, will usually heal without visible complication. But four weeks later, or six weeks later, when the boil may have been forgotten, abscesses of lungs, kidneys, or other organs may bring about a tragic termination. Investigating the course of the original lesion, one feels that incision directly through the indurated, infected skin may have brought about the sepsis. I have seen lung abscess, suppurative pneumonitis, or kidney abscess, so frequently following operations for furunculosis that I may be forgiven for this short paper, to call the matter to the attention of physicians, whether they are surgeons or in general practice. Dermatologists seem to be almost the only ones who are fully aware of this peril, and who treat even the smallest hardened, inflamed areas with respect. They reserve operation until the case has progressed to subcutaneous phlegmon, and only then advise open surgical drainage.

But however the attack is made, direct incision into the furuncle may produce emboli, because the veins, even the small ones, are held patulous by the rigid walls of the indurated skin and will carry tiny plugs of septic matter or bacteria only, in the direction of the blood current toward the heart, and thence to almost any part of the body.

There is danger, too, in making pressure upon the skin centripetal to the opening in a furuncle. If the focus of the boil is open and discharging, it is, of course, desirable to evacuate the necrotic tissue; but this can be done with greater safety by drawing the healthy skin *away* from the slough—or core, as it is popularly known. With two fingers on each side, the skin

may be drawn radially away from the open boil with consequent extrusion of its contents.

Furuncles should usually be treated by a semicircular incision well outside the reddened area, through the normal skin as deep as the superficial fascia. The entire infected area is then dissected upward (preferably) and the boil is excised from within. The flap which formerly was the seat of the furuncle is then replaced over a thin gauze packing which may be withdrawn in two or three days. Healing is usually prompt and unaccompanied by pain. I have operated upon huge carbuncles of the neck by this method, once even extirpating a large one which began deep in the tissues, before there was any superficial redness. The wound was sutured and healed primarily, the diagnosis being confirmed by the pathologist.

The region of the nose and lips is especially a danger zone, because of the countless veins which discharge into the facial and thence into the internal jugular. Indeed, Lexer has advised preoperative ligation of the jugular in extensive indurated septic lesions of the face. In a general examination of the literature I have found a passage by Ayres, Anderson, and Foster<sup>1</sup> in which they state that they "have never observed serious complications in patients with lesions in this (face) area." This seems amazing to me, in view of the considerable number of fatalities which I myself have observed. It is pretty well confirmed in an editorial in the *Journal of the American Medical Association*<sup>2</sup> on the danger of indurated skin infections of the face.

The treatment of these boils or carbuncles of the face, especially those near the nose or in the upper lip, forms an

exception to the general technique, since they require incision through inflamed tissue in spite of the added risk. A method which I have used with success and have described,<sup>3</sup> is efficient and leaves a scarcely visible scar. A quotation follows:

*"Carbuncle of the Lip:* This extremely painful affection is remarkable for the great constitutional disturbance which it often occasions, as well as for the fact that it is actually dangerous to life, on account of its liability to cause thrombosis of the facial vein, which may extend to the deep jugular. There is always a tremendous degree of inflammatory edema, so that the lip becomes enormously distorted, while the rest of the face participates, and the corresponding eye is closed by the swelling. If the infection is in the upper lip, a brawny infiltration extends far up the cheek.

*"Operation:* General anesthesia is required. . . . Ignoring the pustular 'head' of the carbuncle, a generous incision should be made along the line of junction of the skin and the vermilion border, splitting the lip into two flaps by carrying the incision *completely through* the indurated tissues. Now holding the flaps apart with the sharp retractors, several layers of gauze should be passed with the aid of the probe to the bottom of the incision, and then, covering the wound and the lip with a pad of dry gauze, the dressing should be very firmly bandaged into place. There will be smart hemorrhage during this operation, but it is not usually necessary to tie any arteries except perhaps the coronary. The packing and the bandage will in most instances prevent serious bleeding. The dry dressing should be changed in six hours for a wet one. The packing may, if all goes well, be left in place for forty-eight hours. There is usually little or no trouble with the after-treatment of these cases, the large wound healing quickly."

We have here, to be sure, an exception to the method now recommended, but in

view of the location of the disease it is mechanically unavoidable.

Out of many cases illustrating the subject of this article, I will abstract one which typifies what may happen following the incision of indurated skin abscesses, even small ones. The patient was one of my friends, a physician 32 years of age at the time (about twenty-nine years ago). He had two or three small, painful furuncles of the back of his neck on the left side. I made crucial incisions using local anesthesia, and there was apparently prompt recovery. About four weeks later, however, he became suddenly ill with fever, chills, and pain in both renal regions. I catheterized his ureters but found nothing abnormal. In spite of this negative finding I felt so sure that there was acute suppuration, probably in the cortices of the kidneys, that I performed right nephrotomy which yielded no information; nor did the operation seem to change the frightfully rapid course of his disease, and death came about thirty hours later. In those days, *general roentgenologic diagnosis was not common*, and I did not believe that x-ray examination would yield important information. At postmortem examination both lungs were found completely infiltrated with miliary abscesses, obviously the cause of death. Diagnosis of the pulmonary condition by the pathologist was "Staph-septicemia with furunculosis of the lungs."

To the wise ones who determine by a glance at the last paragraph whether or not to read a paper, let me say that this little article deals with the grave dangers which may follow the improper treatment of indurated acute inflammations of the skin exemplified by furuncles and carbuncles.

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# BEDSORES

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IT would seem reasonable in such a presentation to take for granted a familiarity with the basic etiologic factors concerned in the development of bedsores, and also a familiarity with those methods of prophylactic and curative therapy that have been recognized as of value for generations. We will accordingly limit ourselves to the consideration of some of the measures, developed during approximately the last decade, which appear to offer distinct advantages either in the field of prophylaxis or in stimulation of healing.

The nursing care in a given case is of truly paramount importance because of the age of the patient, with attending decrease in skin resistance, or because of obesity, with the added weight and pressure factors, or again because of central nervous system involvement. Consideration of prophylactic measures should immediately be given most complete attention. These prophylactic measures concern chiefly the even distribution of pressure and the prevention of skin maceration.

The most important element in the nursing care of these patients with potential bedsores is the immediate institution of measures to secure even distribution of body pressure. The value of frequent change in position, of carefully inflated air rings and of "doughnuts" of cotton to take pressure from the bony prominences is recognized. There are a few instances, insofar as change in position is concerned, in which keeping the patient prone with considerable elevation of the hips and body by a number of soft pillows beneath the abdomen will promote healing of extensive ulceration over the posterior bony prominences.

The value of this position was well demonstrated in a patient who had had a gun-shot severance of the spinal cord at the fifth dorsal level, two and one-half years before coming under our care. In addition to the trophic factors, which contribute to the formation of bedsores, an infected pilonidal cyst had provided a starting point for an extensive skin slough. My predecessor on service had done an extensive excision, and in attempts to protect the very vulnerable sacral area, the patient had been kept in the lateral decubitus a considerable part of the time; but in the anesthetic, rigid extremities extensive pressure sores, had developed, and over the right lateral femoral condyle one had actually penetrated the capsule of the knee joint with a resultant pyoarthrosis.

The patient was emaciated, the temperature ran a septic course and the outlook appeared most unfavorable. Bilateral midhigh amputation was done. Rustless steel wire was used throughout for ligature and suture in order to reduce tissue irritation to the minimum. A large fraction of the infected areas was thus removed and prompt primary healing secured. We were then able to keep the patient in the prone position and prompt healing of the bedsores followed without the use of other measures than that of the cod-liver oil ointments. We believe that this emphasizes the fact that in such cord cases the factor of anesthesia, which prevents the pain-warning of prolonged pressure, is of greater importance than the trophic or nutritional factors.

Of greater importance, because applicable in all cases, is the question of the type of mattress employed, because no matter

what the position of the patient an even distribution of pressure is necessary. Air and water mattresses have advantages over those of textile construction; but the necessarily firm weave of the outer envelope prevents, in some instances, an accurate moulding over the bony prominences and fails to give an absolutely uniform distribution of pressure. Because of this we would call attention to the advantage of the sponge rubber type of mattress. The texture is such that accurate moulding to the bony irregularities and consequent even distribution of pressure is accomplished and, in addition, the usual slight movements of the patient produce changes in pressure which permit frequent capillary revascularization throughout the day.

For hospital use this type of mattress is said to possess the added advantage of greater durability, and in contrast to the ordinary mattress can be put through the laundry for cleansing. The experience at the Philadelphia General Hospital has been so satisfactory that the Directress of Nursing states that she is looking forward to the time when sponge rubber mattresses will completely displace all others throughout the institution.

The other important problem in prophylactic nursing is the prevention of skin maceration and the accompanying increased susceptibility to the entrance of infection. Maceration depending on excessive sweating is to be treated with bathing, change of linen, the use of skin massage with various rubs having an alcohol base and perhaps the occasional necessity of therapeutic control. By far the more important skin damage comes from incontinence, and fortunately the dangers from this source can now be controlled to a large extent.

With the improvement in catheter construction, the Foley particularly, an in-lying catheter can be installed easily, will aid in preventing skin maceration and will materially lessen the burden of nursing. The question of danger of infection of the bladder may be raised, but the

risk of this complication can be minimized by the simultaneous use of one of the urinary bacteriostatics.

For the male cord case with overflow of retention of "automatic bladder," such as was present in the patient cited earlier, a simple contrivance can be used to carry away the recurrent urine discharge. A piece of rubber tubing secured by ligature or rubber band to a perforated condom will, when the condom is applied and secured to the penis, prove to be a very satisfactory urine conductor and will not prevent the usual mobility of the patient.

Continuation of the above types of prophylactic measures is necessary throughout the patient's illness; but with the advent of indications of inevitable breakdown of the skin, or if the bedsore be actually present when the patient is first seen, active local therapy is also necessary. This local treatment varies with the extent of tissue damage and with the type of ulcer infection present.

The active treatment of bedsore may be grouped under the following headings: (1) local protective therapy; (2) local measures to control infection; (3) local measures to promote granulation and epithelialization; and (4) systemic measures to stimulate healing.

With the patient under careful observation from the onset of illness, a change in prognosis from threatened ulceration to inevitable ulceration is based on the failure of finger pressure on the discolored skin to produce blanching. The lack of blanching indicates capillary thrombosis and therefore maximal impairment of local nutrition. An early break in the skin is inevitable, bacterial invasion commonly soon follows and a rapid spread of the sloughing process may ensue.

In the early superficial areas of abrasion with minimal infection, tannic acid, as used in burns, has proved a very valuable addition to our therapy.

For securing satisfactory protection with this agent the essentials are few: (1) The frequent application (half hour intervals)

of 5 per cent to 10 per cent aqueous solution of tannic acid; (2) the constant exposure of the part to the drying effect of an electric light, under a suitable cradle, until a thick layer of tanned tissue is produced. Should infection develop beneath this coagulum the thick layer must be removed, and the area treated with wet dressing, such as Burow's solution 1:5 or 1:10, until the infection is brought under control, when the tannic acid treatment should again be resumed.

Latimer,<sup>1</sup> Fantus<sup>2</sup> and Spiesman<sup>3</sup> give reports of very satisfactory results following the above technic.

Where the ulcerative process is found to be somewhat deeper, but not rapidly spreading because of the presence of a virulent infection, the protective use of elastic adhesive as suggested by Carty,<sup>4</sup> and subsequently endorsed by Cope,<sup>5</sup> has proved valuable.

Elastic adhesive plaster of sufficient size to cover the open area and the surrounding skin to the distance of one inch is applied in double thickness; or if the area is too large for the width of adhesive at hand, the latter can be overlapped to secure coverage of the area designated. The adhesive is replaced only when it has become loosened and the only treatment applied at such changes is the gentle wiping away of the discharges. By the use of a double layer of adhesive the entrance of contaminating discharges is prevented, and it has been claimed that the retained wound discharges act temporarily as a fluid cushion distributing pressure.

In the presence of a recognizably active infection, as evidenced by progressive enlargement of the area of slough with tissue undermining and skin perforation, it is well to give consideration to the possibility of infection with the micro-aërophylic hemolytic streptococcus described by Meleney.<sup>6</sup> It is desirable to use culture methods to recognize or to exclude the presence of this organism; but if reliable culture technic is not available, I believe the use of zinc peroxide is advisable either (1) as a cream

made up in sterile, distilled water, (2) as a 1 per cent suspension in gelatin or (3) in a 5 per cent pyrophosphate solution. Liberation of oxygen from this chemical in the presence of wound secretions continues over a prolonged period; and experimental and wound culture work has demonstrated the disappearance of other micro-aërophylic organisms from contaminated fields following the use of zinc peroxide.

With improvement in the patient's general condition, natural reparative forces are usually sufficient to effect progressive closure of the ulcerated area. Unfortunately, however, such is not the invariable rule and an open area exposed to repeated local infection, because of the absence of a vigorous granulation layer, may remain stationary or slowly enlarge and prove to be a source of systemic infection; or because of harassing pain it may prevent sleep, break the patient's morale and keep him bedridden over a prolonged period.

Under these circumstances the question is raised concerning the value of chemicals used for the specific purpose of stimulating granulation and epithelialization. Without experimental evidence of individual specific value, much of the local therapy in use for generations has been based on clinical observations which led to the belief of the presence of such cellular stimulating ability. With the primary reports of Reiman on the cellular stimulating effects of the sulphhydryl radical on tissue growths, attention was directed to the use of sulphhydryl preparations in the type of cases under consideration. Brunsting and Simonsin<sup>7</sup> reported on the use of .5 per cent cysteine in equal parts of normal saline and distilled water. The chemical is somewhat irritating to the exposed skin and intermittent application is often desirable. A regimen of alternating two day applications of the cysteine and two day applications of a bland treatment has proved satisfactory. Reiman had reported on the use of parathiocresol in his work, and, according to Klander, had recommended the use of .25 per cent of this chemical in anhydrous wool

fat, applied three times weekly in instances of delayed healing. The odor of this preparation had been objectionable, and the search for a satisfactory, but less annoying, sulphhydryl preparation had resulted in the use by Brunstin and Simonsin of cysteine as reported. In a discussion of this paper J. H. Stokes spoke as follows: "I wish to commend the sulphhydryl preparations in the treatment of bedsore. They are capable of transforming the misery to which these patients are subjected into comparative comfort. I have in mind particularly the spinal paralytic bed-sores. A patient who had almost sloughed away his entire sacral area was relieved of pain and obtained a marvelous effect from it on the bed-sores. The cheaper preparations in spite of their bad odor in the mass, can be handled by skillful packing and attention as to avoid this odor objection and the tendency to skin irritation."

A final measure of growth stimulation is obtainable through the general metabolic response to insulin. Joseph<sup>8</sup> has reported very favorably on the local response, where, despite recognized methods of treatment reparative processes were at a standstill. He advocates five to ten unit doses of insulin t.i.d. and reports cases favorably influenced where the necrotic process was deep.

#### SUMMARY

(1) Prophylaxis by prompt and effectual measures to secure equal distribution of pressure—sponge rubber mattress; (2) prophylaxis by prevention of skin maceration—inlying catheter and/or some type of drainage device; (3) active local therapy for the protection of the early superficially abraded surface—tannic acid as in burns; (4) local protection—by adhesive plaster strapping; (5) control of infection where active—zinc peroxide; (6) local stimulation—sulphhydryl therapy; and (7) general metabolic stimulation—insulin.

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# TECHNIC FOR INJECTION OF VARICOSE VEINS OF THE LOWER EXTREMITIES

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**T**O thrombose satisfactorily varicosities of the lower extremity, it is essential that sclerosing solutions be injected directly into the lumen of the offending

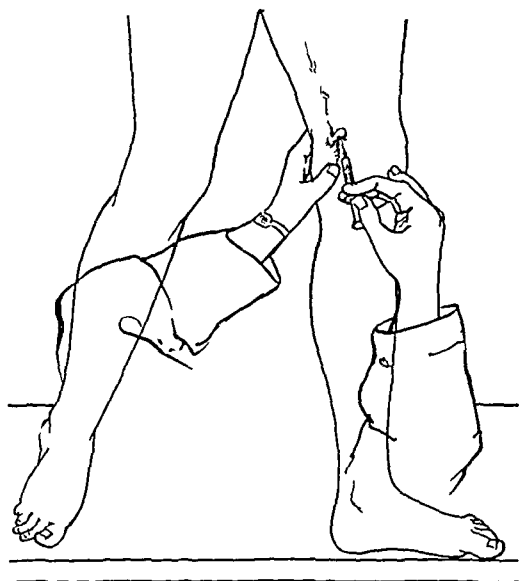


FIG. 1. Relationship of patient to physician during therapeutic procedure.

vein. The technique which we are presenting has proved most valuable in our hands. Its main advantages are: (1) minimal likelihood of perivenous injection; (2) great stability of the needle; (3) good control of the content of the syringe; and (4) lowest possible incidence of failures.

Because almost every patient who undergoes this type of therapy is ambulatory, we recommend that he stand on a table or platform of a height at which the operator can work most comfortably from a sitting position. Acrophobia, due to the patient's elevated position, is usually overcome by

his ability to grasp an adequate support suspended from the ceiling or placed at his side. With the patient standing in the elevated upright position in front of the surgeon, the varicosities, if patent, fill readily and an accurate survey can be made of their distribution. Observation alone in the examination of the patient does not suffice and it is our opinion that palpation is a valuable and dependable adjunct in determining the position and extent of the offending veins.

After the selection of the site at which the injection is to be made, the patient is turned around so that the vein is most accessible to the operator. The patient is further requested to make himself as comfortable as possible and to bear the greater portion of his weight on the extremity which is to be treated. This minimizes movement and adds stability to the vein in the subcutaneous tissues. The operator then usually assumes a comfortable sitting position directly opposite the site selected for treatment. (Fig. 1.)

The skin over the chosen region is cleansed with 1 per cent tincture of iodine or any mild antiseptic solution. For greatest facility, a syringe, preferably of a capacity of 2 or 5 c.c., and a sharp, short-beveled, 26 gauge needle are used. The syringe is held between the index and middle fingers, between the respective distal phalanges. The ulnar surfaces of the ring finger and little finger and, if convenient, the hypothenar surface of the hand are rested against the thigh or leg of the patient for greater stability. With its bevel facing the surface of the thigh or leg and parallel with the longitudinal axis of the vein, the needle is introduced intradermally adjacent to the

vein at an angle of approximately 20 degrees to the skin at that point. As soon as the point of the needle has passed through

this moment, the plunger is released in order to prevent further dilution of the content of the syringe with blood. If the

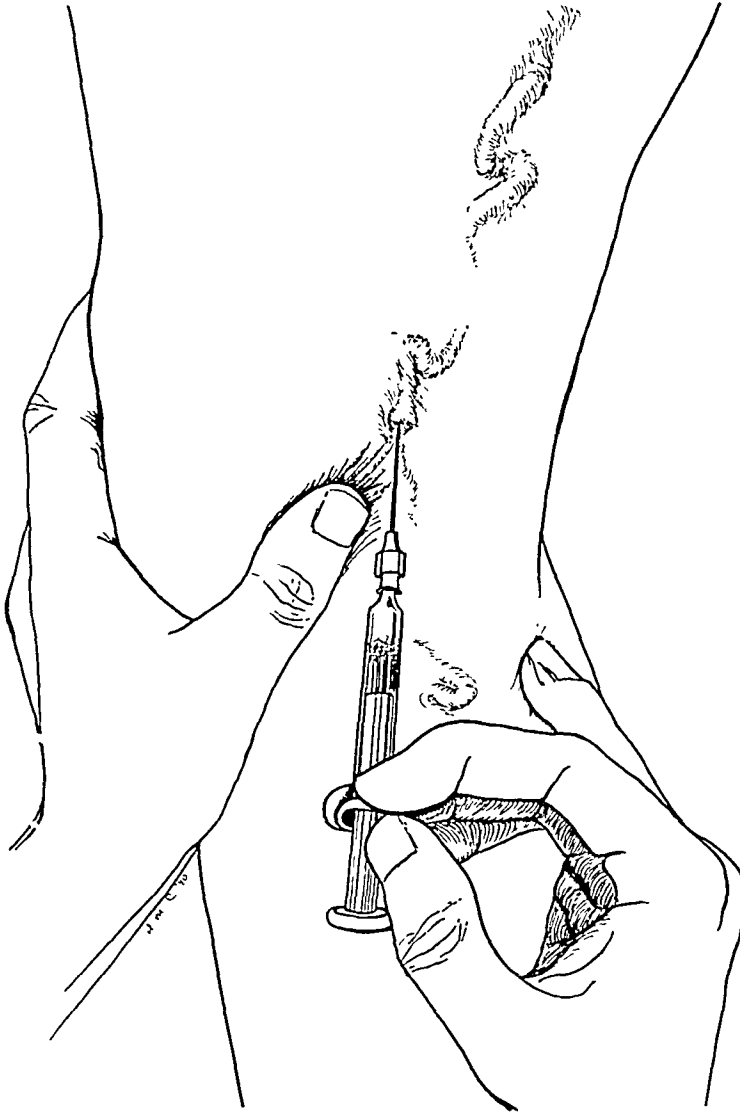


FIG. 2. Manual technic employed for injection therapy.

the skin, the plunger is withdrawn slightly to produce a negative pressure within the syringe. The thumb of the hand that holds the syringe is then pressed firmly against the barrel to hold the plunger in that position and thereby maintain the negative pressure. (Fig. 2.)

With the thumb and fingers of the other hand further stabilizing the tissues, the needle is then slowly advanced toward the vein. When the point of the needle passes through the wall of the varix, blood spurts into the syringe as a result of the negative pressure that has already been created. At

position of the hand against the surface of the extremity is maintained as recommended, the constant relationship of the needle within the vein can be preserved even if the extremity of the patient should move unexpectedly. Throughout the injection, as a further precaution, withdrawal of small amounts of the content of the vein can be carried out at frequent intervals. If excessive pressure is needed to advance the plunger, if abnormal discomfort is experienced by the patient, or if slight swelling appears at the site of the injection, it is wise to discontinue the operation at once

and, at a later date, treat that particular region.

When the desired amount of sclerosing solution has been used, a small, sterile gauze pad is applied to the site of injection. The needle is then removed and moderate pressure is maintained by application of a strip of adhesive tape or by a bandage around the extremity. Thus, the walls of the vein are temporarily compressed to facilitate thrombosis and to avoid escape of the content of the vein as a result of the venipuncture. It should be remembered

that only comparatively slight pressure is necessary to collapse a segment of superficial vein. The patient is advised to remove the gauze pad at the end of two hours, by which time it will have served its purpose.

This technique has proved dependable and satisfactory in dealing with all types and sizes of varicosities of the lower extremities. In occasional instances, some modifications are employed, although fundamentally, the procedure is carried out as described.



*Correction:* In our November issue, on page 336, Dr. H. C. Stein's address was given as White Plains. This should have read New York City.

# VARICOSE VEINS AND ULCERS\*

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AT the present time, the management and treatment of varicose veins and ulcers has been very much simplified due to the better understanding of physical factors concerned in their production and the use of a more or less uniform type of treatment for their correction.

The injection treatment of varicose veins, now almost universally used, has reduced the period of disability to such a marked degree, that there is no question of its superiority over the methods of the past with their long periods of disability and economic loss. Almost all patients may be safely treated by the injection ambulatory method.

## INDICATIONS AND CONTRAINDICATIONS FOR INJECTION TREATMENT

A careful history and physical examination, including pelvic and rectal investigation, should be made on every patient to ascertain the probable cause and mechanism in the production of the varicosities.

The *two absolute contra-indications*<sup>1</sup> to this type of treatment are acute phlebitis and the closure of deep veins by a previous thrombosis.

Varices present in cardiovascular and cardiorenal cases are on the border line.<sup>2</sup> In mild cases of decompensation, the treatment of large varices can serve only to aid the general circulatory condition. If the patient responds correctly to tests showing function of the deep venous circulation and if the circulation in the varicose veins is a reverse flow, treatment seems indicated. Varicosities of the saphenous system due to obstruction in the iliac veins or a blockade in the portal system of veins should be carefully evaluated before any treatment is instituted.

Treatment should be deferred in cases in which *pelvic tumor* is a factor in the production of varices until after such tumor has been removed. The complication of pregnancy<sup>2</sup> should not always be considered a contraindication, when the varices are painful or distressing due to size, particularly in the early months of pregnancy. However, no injection should be given after the seventh month of pregnancy. Painful vulvar varices of pregnancy are included in this group, and when seen about the fifth month respond well to treatment with the proper technic.

Varicosities associated with elephantiasis or in cases of massive edema of the lower extremity, should be considered very carefully. From personal experience, varices in this connection should be considered of secondary importance and treatment directed to the major condition.

## TESTS USED IN THE EXAMINATION OF PATIENTS WITH VARICOSE VEINS

Anatomic studies show that the venous system of the lower extremity consists of a superficial and deep network of veins, which freely anastomose by a series of communicating branches. (Fig. 1.)

The superficial system of veins is composed of the internal or long saphenous vein, which drains chiefly the inner and anterior aspect of the lower extremity, and the short saphenous vein which collects blood from the outer and posterior aspect of the leg. The long saphenous vein enters the femoral vein by piercing the cribriform fascia covering the saphenous opening and the short saphenous vein joins the popliteal vein at the upper border of the popliteal space.

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The deep veins of the leg are situated below the deep fascia in the muscular and bony framework of the extremity. These deep venous channels, after collecting blood from the leg, unite to form the popliteal vein in the popliteal space.

All of these venous channels are equipped with valves to aid in the ascent of the venous blood, and to prevent retrograde flow. It is the impairment in function of these venous valves that lead to incompetence of the venous system of the lower extremity with resulting varicosities.

Much confusion seems to exist in the mind of the average individual concerning the interpretation of the various tests used in the examination of patients who have varicose veins, and for this reason, actual facts obtained from the literature and experience will be used to show what the various tests indicate.

*The greater saphenous system*, comprising the internal or long saphenous vein and its tributaries, should be examined first. The patient should be fully exposed from the groin downward and stand erect before the examiner. The degree of dilatation and the distribution of varicosities, the presence or absence of edema and skin changes are all noted.

To demonstrate incompetence of the greater saphenous system, a practical method has been described and illustrated by McCallig and Heyerdale,<sup>3</sup> "The fingers of one hand are placed over the great saphenous vein, usually at the fossa ovalis, while the fingers of the other hand percuss a dilated segment of vein in the leg below. The percussion stroke is an abrupt thrusting one, so as to give rise to an impulse. If the fingers at the fossa pick up a definite and strong impulse, incompetent valves and a dilated main saphenous trunk are strongly to be suspected. Proof may be established by a reversal of the procedure. If percussion of the vein at the fossa or in the upper portion of the thigh produces an impulse which travels downward to the fingers below and can be definitely felt, we know that the valves are

incompetent and that the vein does not and never will perform its normal function. For such an impulse cannot travel distally in the veins if the valves are competent."

The lesser saphenous system should be examined in a similar way.

In cases where transmission of impulse is indefinite, by the above described method, or further confirmation of existing incompetence in the greater saphenous is desirable, the patient is placed in a recumbent position with the leg elevated to empty its veins. A tourniquet is applied on the uppermost portion of the thigh. The patient is then asked to stand, and if the veins fill rapidly from above downward after release of the tourniquet, the valves of the vein are not holding and the vein is incompetent. The lesser saphenous vein may be tested after the same fashion with the tourniquet applied just below the level of the popliteal space.

*Incompetence of the communicating veins* is usually associated with that of the greater saphenous system. The test described above to confirm incompetence of the greater saphenous system, will, therefore, give similar evidence regarding the communicating veins, by allowing the patient to stand *without* release of the tourniquet, rapid and immediate filling of varicosities of the superficial venous system give evidence of overflow from the deep venous circulation through incompetent communicating veins. To localize communicating vein incompetence more accurately,<sup>4</sup> tourniquets may be placed at different levels on the thigh and the degree to which veins are emptied by walking is evaluated. If the incompetent valves are at the saphenous opening, a tourniquet placed at the top of the thigh will allow fairly complete emptying of the leg veins on walking. If the lower communications are defective, there will be but partial emptying when the tourniquet is at the top of the thigh but more complete emptying when it is applied at the lower part. By estimating the degree to which veins are emptied with the tourniquet applied at different

levels, the exact spot at which the vein with the defective valve empties into the superficial system is identified.

venous system, a Para gum rubber bandage may be applied around the leg<sup>3</sup> from the instep to just above the knee, or as far up

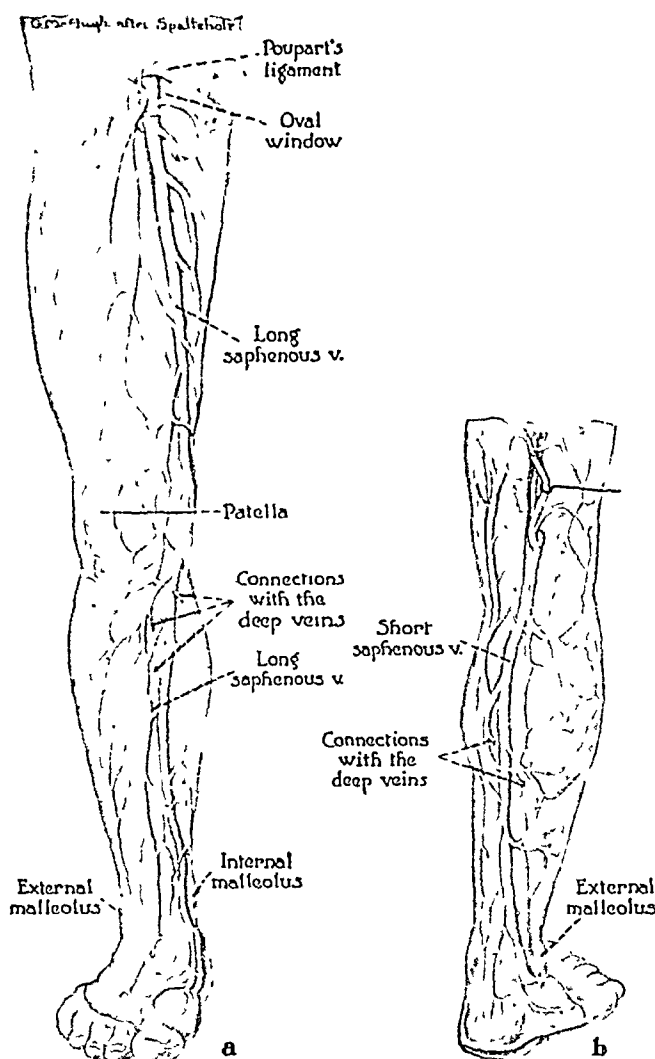


FIG. 1. Superficial venous system of the lower extremity. *a*, anterior view; *b*, posterior view. Both of these figures show the extensive communicating and branching of the superficial veins and easily explain the new formation of varicosities following the removal or obliteration of varicose segments here and there. Note the communicating veins throughout. (H. O. McPheeters and J. K. Anderson. *Injection Treatment of Varicose Veins and Hemorrhoids*, 2nd Ed. Philadelphia, F. A. Davis Company.)

In an evaluation of the *deep venous system*, the most important consideration is persistent occlusion. If edema is absent, one can almost exclude the possibility of complete blockage. The history will usually contain a story of phlebitis, with fever, tenderness and swelling of the leg.

To determine accurately the presence of thrombosis and occlusion of the deep

the thigh as indicated. The patient is instructed to walk about with the bandage in place and to note whether with this activity his discomfort is increased or diminished. If the flow through the venous system is a compensatory one, the constriction caused by the bandage will result in severe discomfort, because those veins which have assumed the function of allow-

ing a return flow of blood from the extremity are compressed. If the flow in the superficial veins is not compensatory, and if a block is not present in the deep circulation, the bandage will give relief by collapsing the useless superficial varicosities.

The injection of sclerosing agents in superficial veins acting as a detour mechanism from the deep circulation is contraindicated. Such treatment will only further retard the venous return from the lower extremity.

In a final analysis of the indications for injection treatment of varicose veins of the leg, it may be said that when it is established by reliable tests that the valves in the saphenous system are incompetent, it is safe to use sclerosing agents to reduce or obliterate the lumen of such veins, except in the presence of serious organic disease, the presence of acute phlebitis or when complete occlusion of the deep venous system exists.

#### TREATMENT OF VARICOSE VEINS

Experience shows that the method of combined high ligation, division and retrograde injection to be the method of choice in the treatment of varicosities of the saphenous system in the presence of demonstrable incompetence. When the varicosities are small and the saphenous system is competent, injection treatment alone is indicated.

*Technic.* The patient can usually be treated as an out-patient without preliminary sedation. The operative field should be shaved and ordinary methods of skin sterilization used. Under local anesthesia, using a 1 per cent solution of procain with adrenalin, a 3 cm. transverse skin incision is made  $2\frac{1}{2}$  cm. below the inguinal ligament over the fossa ovalis. The incision is carried down through the superficial fascia. The position of the femoral artery is ascertained by palpation. By blunt dissection, the greater saphenous vein is usually readily located in the medial portion of the wound deep in the superficial fascia and above the fascia lata. The vein is

isolated from its bed and gentle traction applied while the vessel is dissected free upward and downward. (Fig. 2.)

As the vessel is dissected upward, several tributaries will be found entering the saphenous vein just before it passes through the oval window. All of these tributaries are severed between fine silk ligatures and divided. The saphenous vein is doubly ligated above its highest tributary or at the saphenofemoral junction with No. 2 silk. The vein distal to the ligature is then clamped and divided. The distal segment of vein is exposed and all tributaries within view are divided between fine silk ligatures. A provisional suture of No. 2 silk (A) is placed around the distal vein in the lower limits of the wound. The clamp on the distal vein is now released. A cannula is inserted in the open end of the vein and tied in position with a ligature. Depending on the size of the varices, 2 to 3 cc. of a 5 per cent solution of sodium morrhuate or "moru-quin" (5 per cent sodium morrhuate, 2 per cent alkaloid quinine and 2 per cent benzyl alcohol) are injected slowly. The provisional ligature previously applied below the end of the cannula is now tied. The vein is clamped above the ligature and is divided between the ligature and the clamp to prevent spillage of the sclerosing solution.

The wound should always be protected with moist gauze and flushed with saline solution before closing. Through and through silk sutures are used for closure with an occasional suture for skin approximation.

A supporting woven elastic bandage should be applied from the toes to the knees before the patient leaves the operating table, after which procedure the patient becomes ambulatory. The patient must wear the supporting bandage throughout the course of treatment and report weekly for additional injections needed in the leg or lower thigh.

*Complications.* Wound reaction may occur from spillage of sclerosing solution at the time of operation or leakage after

operation from the distal vein. Such reaction can be avoided by adequate wound protection and careful ligaturing. The

phlebitis develops with injection treatment that there is a possibility of having an embolus after this treatment. Because of

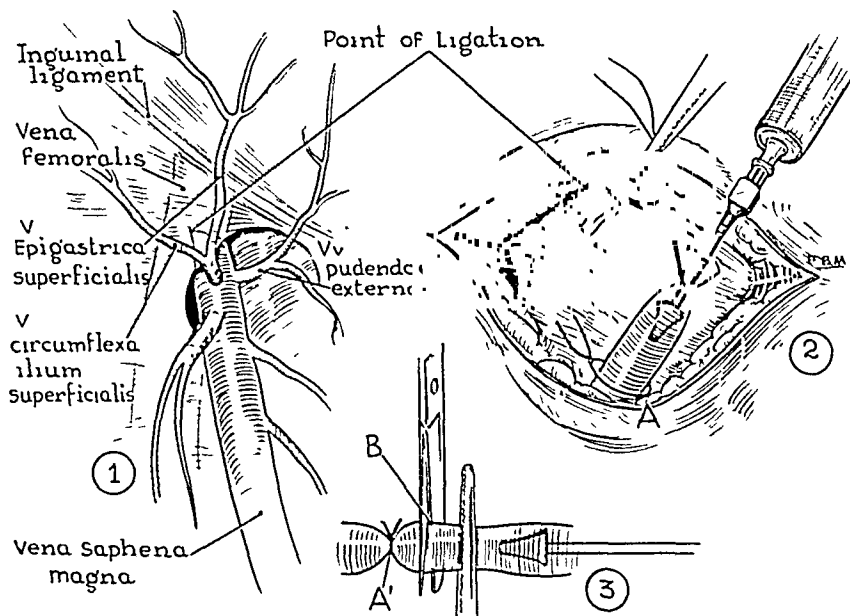


FIG. 2. (1) Schematic drawing showing the point of ligation of the great saphenous vein, proximal to its tributaries at the saphenofemoral junction. (2) The great saphenous vein dissected free with tied-in cannula in place. A, the provisional silk suture to be used for vein ligation after injection of the sclerosing solution. (3) A', the ligature has now been permanently tied. B, division of vein between ligature and clamp.

author has avoided needle puncture of the distal vein for introduction of the sclerosing solution after the application of a permanent ligature for fear of leakage. With the use of the tied in cannula method, as previously described, leakage has not occurred.

*Sloughs* following ordinary injection of sclerosing solutions, are the result of faulty technic, usually, paravenous injection. Before any injection is made, aspiration should be made to prove the position of the needle. Following the injection, a pressure dressing should be applied directly over the site of vein puncture to prevent leakage into the tissues which would cause an unfortunate local reaction.

*Embolism* seldom occurs. McPheeters claims that the mortality rate from pulmonary embolism following injection treatment is seventy times less than that of the operative treatment of varicose veins. He believes that it is only when some complication such as acute infectious thrombo-

the direction of the venous flow in varicose veins, clearly demonstrated by lipiodal injections, emboli from segments of the thrombus breaking loose and spreading into the general circulation are very rare.

#### FAILURE OF INJECTION TREATMENT

Incompetent communicating veins at times cause early canalization in the superficial venous systems by creating unusual pressure at given points of communication. Correction of this condition may be accomplished by injection of the dilated segment of the superficial vein between tourniquets<sup>3</sup> placed above and below the entrance of the incompetent communicating vein. A firm thrombus will usually form preventing retrograde flow from the deep vein.

*Inadequate injections* due to failure of the patient to report for treatment may give poor results. A mutual understanding should exist between the patient and physician concerning follow-up treatment. The patient should understand that when vari-

cose veins appear, a more or less permanent circulatory defect exists, and that follow-up examinations are necessary to detect and



FIG. 3. Varicose ulcers, showing discoloration and pigmentation of the skin, eczema and induration of the tissues.

treat recanalization or newly formed varicosities.

#### VARICOSE ULCERS

Varicose ulcers are the result of incompetency of the venous circulation of the leg. The initial factors are usually varicose veins or deep vein thrombophlebitis. When these factors are present, nutrition is disturbed due to stasis of tissue fluids, rendering the leg vulnerable to infection. Ulcer may result from mild trauma or friction. The breaking of the skin surface and the susceptibility of the tissues to infection lead to a rapid necrosis with the formation of the characteristic varicose ulcer.

The *diagnosis* of *varicose ulcer* is usually obvious. They usually occur on the lower inner side of the leg associated with skin changes and varicosities. (Fig. 3.) The base of the ulcer is shallow with cyanotic granulations. Local pain and tenderness are common.

The *syphilitic ulcer* usually occurs in the upper part of the leg. The ulcer is punched

out, usually deeper than the varicose ulcer and has a washed, leather appearance. The Wassermann test will be positive.

*Tuberculous ulcers* are rare on the leg.

*Trophic ulcers* usually result from long standing debilitating disease or local conditions bringing about constant pressure as from cast or brace. The skin first becomes dark red; rapid necrosis and ulceration to the bone often occur.

*Malignant ulcers* are infrequent on the lower extremities. However, when an ulcer does not respond to appropriate treatment, biopsy should be taken for histologic study.

The prognosis in varicose ulcer will depend on how efficiently one is able to stabilize the venous circulation of the leg. If competence of the saphenous system can be restored and maintained, permanent healing of varicose ulcer is to be expected. In cases of ulcer with advanced skin changes and indurative processes resulting from long standing chronic passive congestion, healing is retarded despite the most efficient management. When such an ulcer has healed, careful follow-up is essential to prevent recurrence.

*Treatment.* In recent years, the treatment of varicose ulcer has depended to a large extent on the application of mechanical pressure and for the most part has been ambulatory. This modern treatment is based on the principle that when the patient walks, muscular contraction aids in expelling blood from the leg veins toward the heart. Particularly is this true of the deep veins which seldom become incompetent. With incompetency of the superficial veins resulting in varicosities, the flow of blood is more or less influenced by gravity. When the patient stands, varicose veins will be filled with blood and the flow toward the heart is markedly diminished. When compression is applied to the leg, the reverse flow of blood in varicose veins is prevented, and with the patient ambulant, muscular action will aid in expelling blood from the deep circulation of the leg, thus maintaining more or less normal circulatory balance.

It has been shown that with the application of a supporting elastic bandage combined with rubber sponge pressure, the reverse flow of blood in the venous system into the ulcer can be overcome and thus the excessive accumulations of fluid in the tissues about the ulcer, which causes a lowered resistance locally, can be stopped. The resiliency of the rubber sponge with its massage effect, brought about by the muscular contraction of walking, has been likened unto a "rubber or venous heart." (McPheeters.) Thus with activity, the circulation in the area of ulceration is improved.

In all cases, a careful preliminary examination is made to rule out important complicating factors such as diabetes, nephritis and cardiac decompensation. These diseases should receive appropriate treatment while investigating the etiology of the ulcer.

The ulcer area is cleansed with tincture of green soap followed by alcohol, and is now ready for the application of the dressing. A dry dressing consisting of several layers of gauze is placed over the ulcer sufficiently thick to absorb wound secretion. A *rubber bath sponge* is selected which will overlap the edges of the ulcer. This is applied directly over the gauze dressing covering the ulcer. *The dressing over the ulcer should be inspected to make sure that the sponge pressure is placed directly over the ulcer.* Additional dressings are applied over the sponge and firmly bandaged in position by a 3 inch or 4 inch gauze bandage. A 4 inch elastic (Ace) bandage is applied to the leg from the toes to the knee. (Fig. 4.) It is important in bandaging the leg that equal and firm pressure be applied throughout. The patient is instructed to keep active and is encouraged to walk. Dressings should be changed as required, depending on the amount of drainage. This type of treatment should be continued until the ulcer is healed when the sponge may be discarded. The elastic compression bandage must be continued

during and after the completion of treatment.

The injection treatment of the varicose

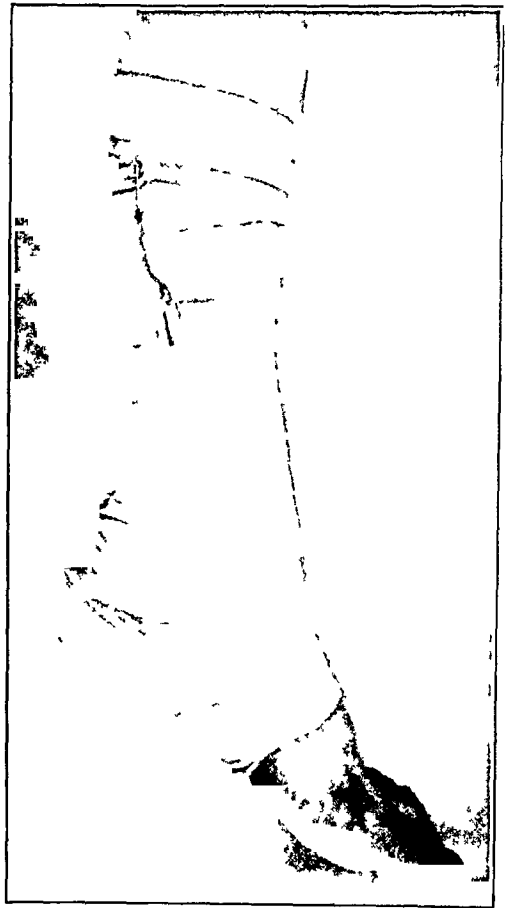


FIG. 4. Entire lower leg including rubber sponge now firmly bandaged with a 4 inch Ace bandage. Following this the patient is instructed to walk. (H. O. McPheeters and J. K. Anderson. *Injection Treatment of Varicose Veins and Hemorrhoids*, 2nd Ed. Philadelphia, F. A. Davis Company.)

veins may begin at any time. The writer prefers to wait until pain and local signs of inflammation in the ulcer area subside with compression treatment. High ligation, division and retrograde injection of the great saphenous vein is performed to be followed by subsequent local injections of sclerosing solution in remaining varicosities.

*Comment.* The use of ointments in the treatment of varicose ulcer as a routine, has been abandoned. Ointments have a tendency to retain wound secretion and in some cases seem to cause skin maceration and delayed healing. In the late phases of

ulcer repair, with sluggish granulations, a mildly stimulating and drying ointment is suggested. For this purpose, a 50 per cent ointment of bismuth subnitrate in petrolatum may be used.

*Skin grafting* in cases of varicose ulcer is seldom indicated or required. In the presence of healthy granulations and wide skin defect, remaining after the elastic compression method of treatment and associated varicosities have been obliterated, skin grafts may be used to hasten recovery. When skin grafts are used, it is essential that recumbent treatment replace ambulant treatment until the grafts are firmly fixed. Elastic compression bandage or Unna's paste boot should be worn continuously when the patient becomes ambulant.

The use of *Unna's paste boot* in the management of varicose veins and varicose ulcers as a means of obtaining gentle elastic pressure has proved to be very effective in the hands of those regularly accustomed to its use.<sup>5</sup> In the case of the punched out or deep ulcer, the rubber sponge may be used under the boot to apply elastic pressure to the floor of the defect.

As with varicose veins, the final result of treatment will depend on the careful follow-up management. The patient should be instructed to avoid trauma, and should be made familiar with the early use of

bandage compression of the leg in the presence of signs suggesting recurrence of ulcer.

#### SUMMARY

The successful management of varicose veins and varicose ulcers requires a clear understanding of the anatomy of the venous system of the leg and the sequence of events associated with incompetency of the greater saphenous system and its tributaries.

The results of treatment will depend not only on the correct interpretation of tests for incompetency and the proper application of treatment, but the close cooperation of patient and physician during the entire course of treatment and for a long time thereafter, to prevent recurrence of varicosity and ulcer.

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# WOUND CLOSURE, WITH PARTICULAR REFERENCE TO THE AVOIDANCE OF SCARS

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**M**EN have been repairing skin wounds for thousands of years. With the gradual advancement of surgery there has been an improvement in healing and wound closure. Today the average patient is likely to judge the surgeon, regardless of his diagnostic acumen, by the appearance of his incisions postoperatively.

The human body has not changed particularly in its healing powers, and in the length of time that has elapsed in surgical experience it would seem that there should be no problem of scarring following wound closure. Yet court calendars are filled with traffic personal injury cases demanding damages for scars following injuries. The majority of these patients have had attention by the first physician available or at the hands of receiving hospitals. The chances are that these were not the ideal wounds for repair.

*Ideal Wound for Closure.* The ideal wound is in a region allowing adequate pressure for immobilization following closure. The wound edges are of the same thickness and viability; the axis runs in the direction of the grain of the skin, so that the edges may be drawn together with a minimum of tension, or may be sufficiently undermined to assure easy closure.

*Plan of Incision for Closure.* This then should be the picture of the incisions of a planned operative procedure, but the resultant scars often transcend the deformity for which relief was planned. No one surgeon has yet achieved a scarless technic that holds good for all cases. However, we may attain increasing peace of mind by adherence to proved methods and in the presence of resultant scars attribute them to a slip in the technic or to the condition of the tissue.

*Condition of Tissue.* A healthy skin naturally presupposes perfect healing. Implant in it an acne, with some acute pustules, or cover a body having a lowered metabolic rate, and we are likely to see red, indurated scars which may go on to keloid formation. If the area of wound closure is in a hair-bearing region or near one of the orifices of the body where it is subject to contamination, our picture changes, although the skin may seem to be in perfect health.

*New Wound Closure.* The recent traumatic wound has a much better chance of healing kindly if the policy of conservative debridement (somewhat analogous to the clipping of flower stems to freshen them) is employed. Much damage, however, has been done by indiscriminate debridement which was advocated by Diffenbach 100 years ago, especially around joint areas and body orifices, a lesson we are relearning by experience since the necessities of the first World War surgery.

One surgeon will repair a recent wound with an excellent nonscarring result while another, under practically the same conditions, will have an utter failure cosmetically due to the rough handling of the tissues involved. "In every union there is a mystery—a certain invisible bond which must not be disturbed." (Amiel.) Preoperatively, the more meticulous the gentle soap and water scrub, followed by the removal of the soap by irrigation with normal saline, the less the necessity for the use of antiseptics. The fact that many wounds heal perfectly in spite of a careless preparation and closure should not encourage us to incur risks.

*Closure Following Scar Removal.* An area which has been allowed to heal by itself presents a problem of just how much

\* Dr. Howard L. Updegraff died on August 8, 1940.



of the surrounding skin has been pulled over the healed area to satisfy the demands of the scar contraction. To the occasional dabbler in scar removal, the startling deficiency of tissue often following excision of the scar is a matter of sudden and grave concern as how best to repair.

If the old adage is true that no surgeon should open an abdomen without possessing the technical skill necessary to perform an intestinal anastomosis, then no surgeon should attempt the removal of an area of full thickness skin without the ability to employ the correct procedure to close the defect, even to graft skin if necessary, unless he is willing to explain a secondary closure or alibi bad scars.

While we are speaking of the avoidance of scars, let us designate the scars under discussion as those visualized by surgeons, rather than by patients, no two of whom have the same "mental" scar picture and whose experience is usually limited to members of their immediate family and varies from appendectomy incisions to vaccination marks.

Wound closure, in the presence of keloidal history, should be planned with the thought of early removal of sutures followed by adhesive support and treatment by radium with platinum filtration in divided doses. Preliminary radiation may be used, if employed either just before surgery or a sufficient period previously, so that surgery does not come during the reaction period. The term, "keloid" is another expression of which the average patient needs a definition and an accompanying explanation for its possible appearance.

*Instruments.* The planning and marking of incisions plotted so as to take advantage of the skin grain and tension lines should come under the head of "preoperative meditation." Five minutes spent in checking needles, sutures and general instrument setup, will save much time later, as the best of operating room nurses fail to put everything in at times. If we are to give special consideration to the avoidance of scars, it will be necessary for us to include

in our "instrumentarium" a few items dedicated to such an aim.

First in importance are a half dozen small, single and double hooks of stainless steel with handles from four to eight inches long. With a little practice, they take the place of retractors or may be used in lieu of basting sutures, and if placed in the angles of the incision, greatly aid in correct closure. Their traumatizing quota is small and this influence should be continued in the choice of thumb forceps and mosquito clamps. Needle holders and small needles should be chosen for the site where they are to be used and for their sturdiness, in accordance with the toughness of the tissue undergoing repair. Thumb forceps with a minimum of crushing power and of slight resistance to one's holding grasp, keep the touch gentle. A good example is the Adson meningeal forceps. New Bard-Parker blades are dependable for clean cut edges. Full curved cutting needles such as Lane cleft palate or eye needles are excellent for skin suturing.

There should be a tendency to evert all incision edges rather than invert, unless one is deliberately trying to make a scar fit into the trough of a wrinkle. Undermining ordinarily should be as much again on either side as the width of the defect to be closed. Mild suction correctly placed at dependent drainage points is much kindlier to tissue than gauze mopping.

*Sutures.* Suture needs should be visualized before surgery. Catgut and silk size orders should specify the manufacturer, as no two have the same standard of sizes. The use of silkworm gut and horsehair for skin closure is fast losing favor. Dermal with buttons for deep tension support is acceptable, provided the buttons are pillowed with vaseline gauze.

The correct size suture is the smallest one allowing approximation without breaking. The ideal suture then should allow easy apposition and yet adequate splinting against underlying muscle action. The breaking of sutures is usually an indictment of the surgeon rather than of defective

suture material. "Tying with the elbows," is still considered bad form in the surgical "Emily Post."

It is our practice to use triple 0 plain catgut for ties and subcutaneous approximation and double 0 plain catgut for important tension points. Chromic catgut is used only where deeply buried. Silk has come to be the suture of choice for skin approximation, and covered by several layers of vaseline paraffine gauze, may be left in place from two to five days until it becomes too tight or too loose. The use of buried silk will continue to gain favor, as long as it is buried deep and is fine enough. Mason states that "the heaviest silk should not be larger than the smallest catgut."

*Wound Support.* Skin support following closure is of immense value, regardless of the length of the incision line, as the smallest scar in a prominent place may be a source of great embarrassment to the patient and incidentally the surgeon. The removal of the sutures is a double incentive to support, best obtained by crosswise adhesive strips, in which diamond-shaped perforations have been made to insure escape of possible drainage. These strips should be applied with the thought of not only holding the wounds edges together, but also of combating possible extra tension from increased movement as convalescence progresses.

Facial scars are more acceptable, if dressed with "flesh color" adhesive. The patient will wear it much longer and the incision line will benefit accordingly. As a matter of psychology I have noticed that patients with mastopexies and lipectomies, (commonly covered areas), object less to flesh colored adhesive over longer periods of time, than those subjected to ordinary adhesive, especially the "water proof" types which are too hard and stiff for ordinary wound support.

The main objection to the use of adhesive in the supporting of wound edges seems to be in the pain occasioned by its removal. Numerous agents for removal have been placed on the market. Ordinary benzine

carefully introduced by cotton applicators between the skin and the adhesive is a satisfactory method, if care and skill are combined with its use. Many a new patient comes to the surgeon recommended by his reputation for gentleness in removing dressings, rather than for his skill in the operating room.

On certain types of oily skin and on babies' faces, where adhesive is sometimes especially irritating if removed often, one may lengthen the period between removals if they will first cleanse the skin with benzine and alcohol, and then paint with compound tincture of benzoin to form a protective and improved base for the adhesive. This is also advantageous during cold weather when even the flaming of adhesive is not always sufficient to make it stick.

*Support of Abdominal Incisions.* Following hospitalization the average patient is often sent home with an ill-fitting abdominal support, which usually irritates the recipient enough to make him forget the surgeon's kindness in the hospital. The wound edges soon register permanent protest in the shape of angry scars for months to come.

The support of abdominal incisions by "adhesive corsets" made up of three inch strips of adhesive, with hooks for tape lacing, aids materially in changing dressings. Following the removal of sutures additional support should be applied for at least thirty days by crosswise one inch wide adhesive strips with perforated openings over the incision line. The combined adhesive strips should be wide enough and long enough to act as a girdle and they need not be changed every time the patient appears. The portion over the incision line may be renewed when soiled and superimposed adhesive placed over the old which is left on to protect the outlying skin.

The support of abdominal scars with adhesive tape should be figured in weeks rather than days, if one is to combat widened scars successfully (and bridgeable conversation of results). Following removal of the adhesive support cross

strips, a single piece of adhesive slightly wider than the actual scar surface and the length of the incision should be applied. This may be done by the patient after a suitable time and gives him a feeling of continued partial immobilization and support.

*Immobilization and Pressure.* Immobilization of wound edges is of course the aim of wound closure. Various additional procedures may be utilized, as for instance, the "Bowman splint" used for postoperative harelip dressings, may be used for support of any other exposed suture line. The late John Wheeler, one of our greatest eye surgeons, was a staunch advocate of sewing the eyelids together in many types of surgical repair of the eyelids. The use of plaster of Paris for support, now being replaced by a lighter cast material, is an aid to immobilization that has achieved merited popularity. The combination of such as these, with the use of intelligently applied pressure on the sutured and undermined surfaces, further aid scar avoidance.

Pressure is employed as a splinting measure in clean recent wounds and as a preventive of hemorrhage, edema and localized postoperative movement. It should encompass the undermined area and be of sufficient force to control arterial and venous circulation of the skin yet allow the flow of lymph. This amount of pressure has been determined as around 15 mm. of mercury. Favorite methods vary from fluffed gauze under stockinet bandage reinforced by adhesive to a marine sea sponge cut to size and similarly held. Sufficient compression should be applied preliminary to bandaging to express any blood clot which might have formed previous to the beginning of this period of immobilization.

It is most important that restraint and major splinting protect the initial dressing. The possible employment of ice bags, sand bags, pillows, with the prescribing of the correct position and administration of sufficient sedatives or narcotics along with possible shock measure, must be kept in mind. "Primary union with a minimum of disturbance" then is the watchword

made possible through immobilization. The word, "immobilization," means different things to different patients. The average patient interprets it as meaning to stay in the house and possibly bed yet he will chew gum, brush teeth, smoke and have lengthy phone conversations in the presence of a complicated facial scar repair unless specifically warned not to.

*General Surgical Conditions Influencing Closure.* The type of dressing is influenced somewhat by the choice of anesthesia and should be planned, not only for pressure and possibility of early inspection of the wound, but also for its removability postoperatively. Wounds in the hair line should be shaved and the use of collodion and adhesive on unshaven areas should be given thought before applying. This is especially true in elective surgery. The use of caps, mask over nose and gloves are of the same importance as in abdominal surgery, especially in rib cartilage grafts. Yet we all have seen completely regimented operating rooms, visited by the Chief of Staff in a business suit sans mask or gown, or the head nurse of the operating room floor cruising from one surgical unit to another, evidently protected from delivering infection by her title.

*Anesthesia.* One of the most important features of hospitalization for emergency wound closure is that it include the services of an experienced anesthetist. He should be given sufficient time if possible to size up the patient, so as to chart his course depending on the general condition, necessity of shock treatment, need of preoperative medication and some inkling of the time involved for the repair.

I like endotracheal anesthesia as an adjuvant for the majority of wound closures coming under the grist of facial plastic surgery. While the introductory measures are time consuming, they save in repair time and offer a far greater return by divorcing the anesthesia problem from the surgical area. For elective surgery with its extended periods of time, it is the method par excellence. Anesthesia makes little

difference in scar formation following wound closure, except as an aid to the surgeon to allow him to do a better repair. Different types of patients, surroundings and physical conditions all demand their equivalents in the choice of an anesthesia. The main point is that the surgeon who will be held responsible in the end for scars should assert himself at the time of surgery for the use of those aids which will help him the most.

#### COMMENT

The most successful wound closures with a minimum of scarring are obtained only in the security of the operating room. Here are multiple advantages, such as repairing the wound at the best time for the patient, elimination of the haste engendered by the

necessity of shock treatment and the promise of after care allowing for the administration of anesthesia and preoperative and postoperative sedatives. Added to this is the possibility of adequate and thorough cleansing of the wound with the option of immediate or delayed repair. The so-called six hour time limit for infection may be reasonably extended under the favorable circumstances of hospitalization and the possibility of hospital after care. The disadvantages which exist in the combination of an onlooking family and friends, in an office not designed exclusively for surgery, versus the advantages and serenity of a masked and gloved operating room staff, cannot be compared when the final score is posted for the presence or absence of good results, namely, scars.



# THE CORRECTION OF SCARS<sup>\*</sup>

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SCARS usually follow the destruction of tissue resulting from trauma, burns, operation or disease. Their appear-

*The Correction of Simple Scars.* The simple scar, whether smooth or hypertrophic, is not always easy to correct. The

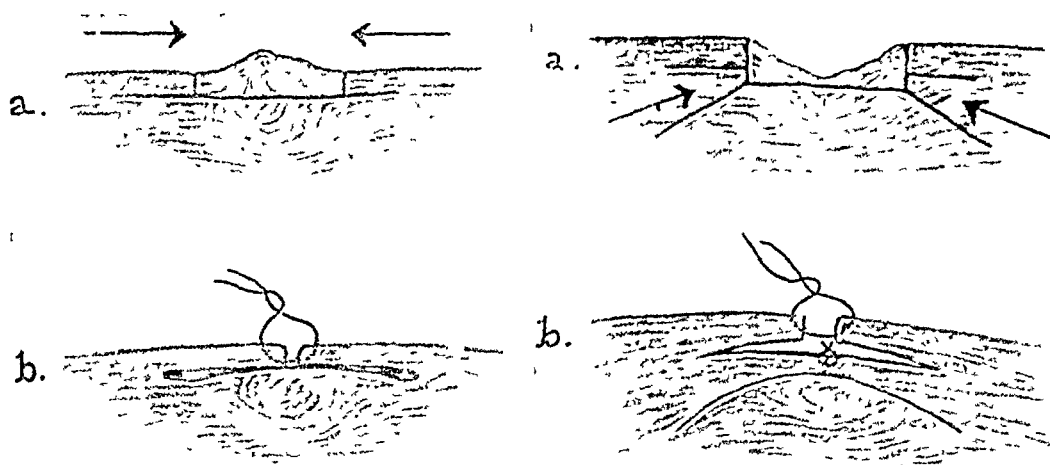


FIG. 1. *a*, correction of simple hypertrophic scar; excision of scar, leaving basis of scar intact upon which the wound edges are approximated. *b*, correction of simple depressed scar; excision of scar leaving basis of retracted area intact. From the corners of the defect a bilateral incision is carried obliquely downward and outward. The mobilized skin and subcutaneous tissue is approximated upon the scar buttress.

ance or their painfulness may annoy the patient or they may cause limitation of function. If an operative correction of such scars is undertaken, several general rules must be observed. The tissue which formed the scar must have reached a state of quiescence, recognizable by the pale color and softness of the scar. With a simple scar this stage may be reached by the end of the fourth week. Scars due to burns, however, may not be operable before the end of a year. Massage and x-ray treatment often help to shorten this time.

In discussing the plastic repair of scars it is important to distinguish between simple and extensive scars. Both types can be smooth, hypertrophic, depressed or contracted.

incision outlines the scar and penetrates at either side of the scar into the subcutaneous tissue, but not deeper. The subcutaneous tissue is kept intact to act as a basis upon which the wound edges should be approximated. (Fig. 1A.) With a pair of fine, sharp, curved scissors the scar is excised. The wound edges are mobilized and separated from the subcutaneous tissue in a circumference of about 1 cm. Exact hemostasis is the next step. If possible, ligatures should be avoided and the bleeding controlled by pressure. If ligatures are unavoidable they should be made with the finest silk. The suture of the wound edges should be carried out with horsehair and consist of on-end mattress sutures supplemented with simple interrupted sutures.

<sup>\*</sup> From the Surgical Services of Lankenau, Germantown and Chestnut Hill Hospitals. Presented before the Philadelphia Academy of Surgery, November 6, 1939.

The wound edges are not grasped with a forceps but only elevated by one prong to facilitate the penetration of the needle.

If the simple scar is *contracted*, the entire scar tissue, including the base, must be excised until the whole defect thus created

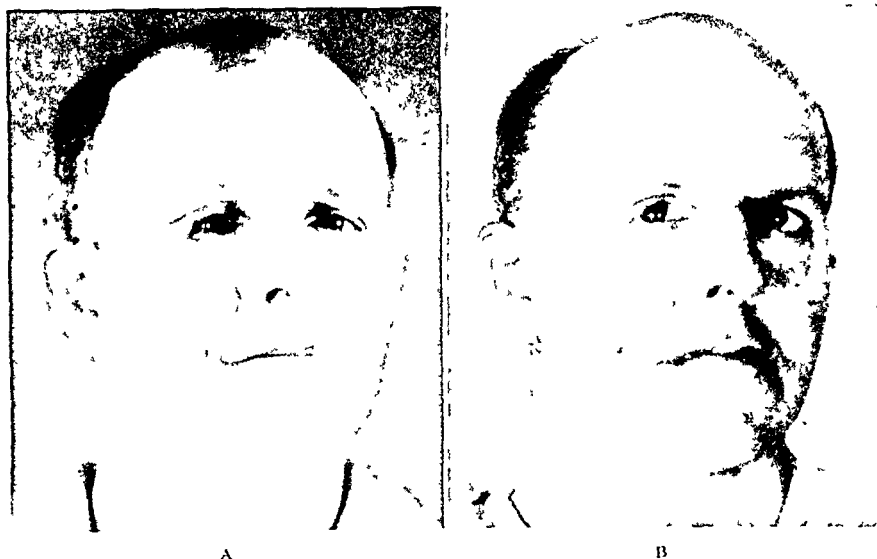


FIG. 2. A, correction of depressed scar in right nasolabial fold and of contracted scar of lateral part of right eyelid. B, scar in nasolabial fold corrected according to technic as represented in Figure 1b; scar of right eyelid corrected with Z method.

If the wound edges are not under tension and are straight, Halsted's subcuticular wire suture is of value. I prefer to cover the wound with silver foil which keeps it dry and aseptic. The simple sutures are removed on the second or third day; the remaining sutures on the fifth day after operation.

If the simple scar is *depressed*, the technique for correction differs. The incision outlines the scar and penetrates at either side to the base of the retracted area, but not further. The scar is now excised as previously described. From the deep corners of the defect a bilateral incision is carried obliquely downward and outward, leaving the base of the scar intact to act as a buttress. (Fig. 1B.) The adjoining tissue thus mobilized is approximated upon this buttress and transfixed by on-end mattress sutures supplemented with simple interrupted sutures. (Fig. 2.) In some instances it is better to suture subcutaneous tissue and skin in layers after mobilization of the skin edges from the subcutaneous tissue.

consists of normal tissue. One ordinarily succeeds now in releasing the contracture unless the latter has been of long standing. Usually some sort of tissue shifting is necessary to close the defect. In cases where the contracture is due to a binding web the Z type of relaxation incision with exchanging flaps is the operation of choice (Davis<sup>1,2</sup>). The object of this operation is to interrupt and displace the binding web by the formation and transposition of two triangular flaps which are placed so that their outlines form a Z. The central line of the Z is laid along the most prominent portion of the web and the arms of the Z are marked out on opposite sides of the central line. The two triangular flaps thus outlined are mobilized. The contracture is now reduced as far as possible and the two flaps are transposed. If the binding web is long, several such Z's may be formed and their flaps transposed as demonstrated in Figure 3.

*Correction of Extensive Scars.* Extensive smooth scars are in the same plane as the skin. Ordinarily they do not cause any

trouble since they do not contract. However, they tend to become annoying if they are situated in such exposed regions as

(Fig. 5) and the surrounding skin is freely movable, plastic closure might be achieved by starting with closure of the

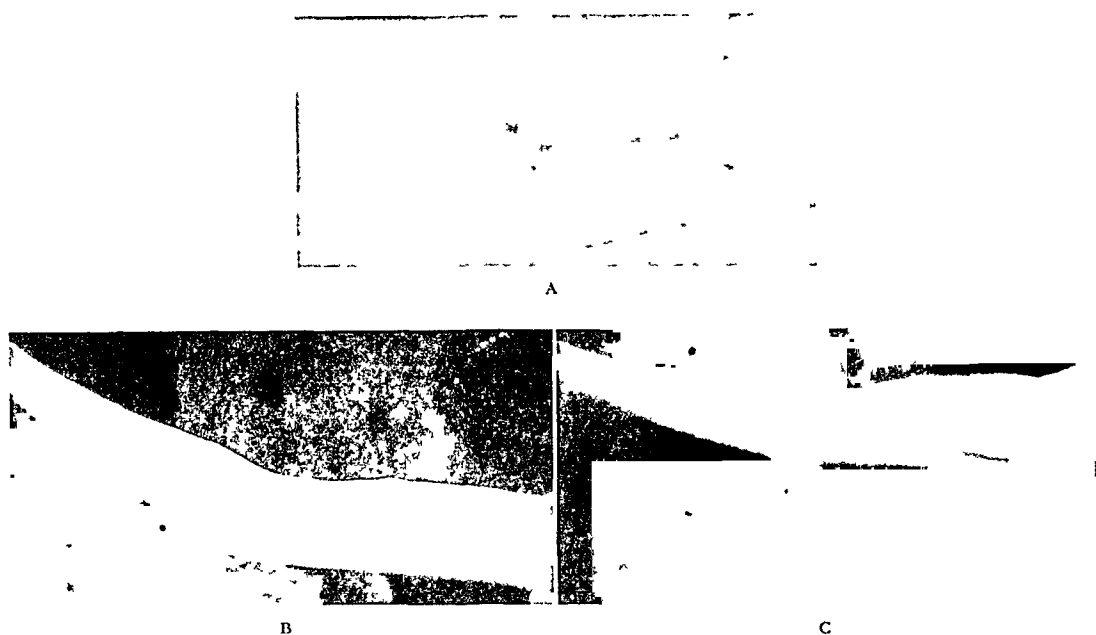


FIG. 3 A, correction of simple contracted scar by the Z type of operation. The central lines of the two Z's are laid along the web. The arms of the Z's are marked out on opposite sides of the central lines. The two triangular flaps of each Z are transposed. B, same patient six months after operation. C, same patient one year after operation.



FIG. 4 Triangular defect after excision of flat scar closed by starting with closure of the corners.

the face or neck. In these cases repair work may be requested. If the scar is not too extensive and elliptical and the surrounding skin is freely movable, the scar is treated as if it were simple and smooth. It is excised down to the subcutaneous tissue, but not further. The wound edges are mobilized subcutaneously and approximated until a linear suture can be established. If the defect left after excision of the scar is triangular (Fig. 4) or rectangular

corners.<sup>3</sup> It is important to avoid undue tension in the sutures by choosing a procedure by which the scar is partially excised and sutured in several stages. During the intervals the skin is allowed to stretch until all parts of the scar are removed. If the scar is too large to permit closure of the defect by simple tissue mobilization or tissue gliding, covering of the defect by a full thickness skin graft or pedicle flap is advisable. The disadvantage

of the graft or flap, however, is the difference of color and a slower healing process.<sup>4</sup>

The *extensive hypertrophic scar* is usually

can be established. X-ray treatment is applied postoperatively. If this scar, in spite of excision and radiation, develops



FIG. 5. A, rectangular defect after excision of large keloid scar closed by starting with closure of the corners. B, same patient ten months after operation.



FIG. 6. A, large depressed scar of forehead with displacement of right eyebrow. B, same patient seven months after excision of scar, rotation of right side of scalp and transplantation of fat tissue.

due to keloid formation. We do not know as yet the cause of keloid development and for this reason the treatment is rather vague. It is a well known fact that even after a complete excision of a keloid it may recur after a few weeks no matter whether the defect is sutured primarily, covered by a skin graft, left to granulate, or electrocoagulated. The most efficient treatment at the present time is radiation by x-ray or radium, preferably after excision of the scar. If the keloid extends over a large area and this area happens to be in a place where the skin is very movable, one may attempt an excision of the entire area. The skin surrounding the defect is mobilized and approximated until a linear suture

again into a keloid, the second is many times smaller than the first. (Fig. 5.)

If an extensive scar is retracted or depressed, the technique of correction differs from that used in simple depressed scars. In the majority of cases the involved area is too large to allow an approximation of the neighboring subcutaneous tissue to fill the defect. Hence the repair work is mostly combined with grafting fat, bone or cartilage in order to restore the normal surface contours. The scar is excised down to its base. The skin surrounding the defect is mobilized; then, after careful hemostasis, a properly shaped piece of bone, cartilage or fat is transplanted into the defect before the skin is closed over it. The choice of the



material is not free but is dictated by local conditions. If grafts of fat tissue are used their subsequent shrinkage must be taken

of skin by pedicled flaps is the last resort. A patient was kicked by a mule on the right side of the forehead when he was

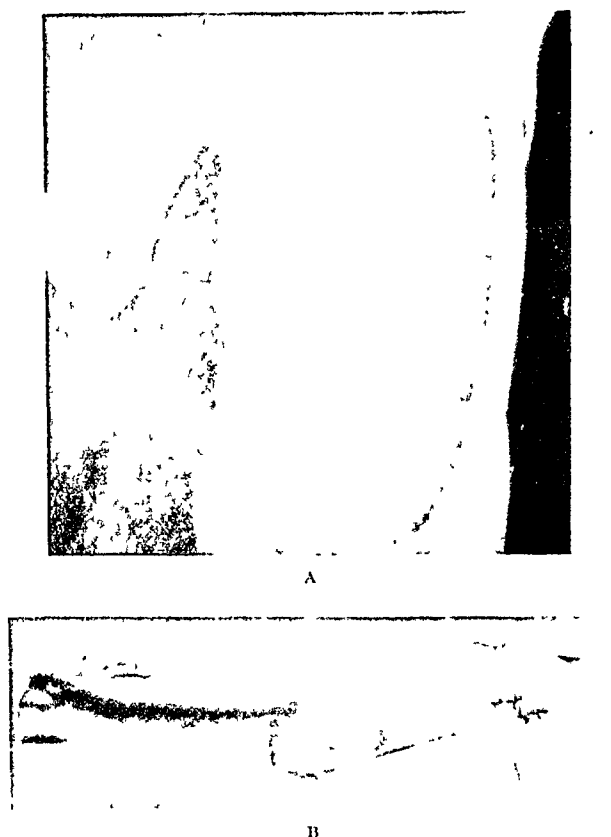


FIG. 7. A, eight year old boy with contracted scar of right elbow joint and axilla due to burns. The burned area included the entire right half of chest and abdomen. A tubed flap was formed from left thoracico epigastric region (Webster). B, the tubed flap was transplanted into the defect of the right elbow after contraction had been overcome. Contraction of right axilla was corrected by the Z operation.

into consideration. The shrinkage amounts to about two-thirds of the size of the graft. Cartilage and bone are not apt to shrink. I prefer to take fat tissue grafts from the outer posterior surface of the thigh, cartilaginous tissue from the fused portions of the seventh and eighth ribs, and bone from the anterior surface of the tibia. If simple mobilization of the skin does not suffice to close the defect over the graft, additional incisions must be made to allow more liberal shifting or rotation of skin. In such cases, however, secondary defects may be left and one must be sure that they can be closed. In extreme cases transplantation

4 years old and acquired a deep depressed scar due to bone and skin defect. His right eyebrow was split and the lateral half displaced upward. (Fig. 6.) When he was 21, I excised the entire scar, mobilized the surrounding skin and filled the depressed part with fat tissue taken from his left thigh. To rotate the displaced lateral half of the right eyebrow the incision was lengthened upward and backward, thus outlining a large flap consisting of nearly the entire right half of his scalp. The flap was mobilized and was then easily shifted downward, covering the original defect and allowing alignment of the right

eyebrow. The secondary defect at the occiput could then be closed.

#### Correction of extensive contracted scars

conditions and the peculiarities of the various kinds of transplants. (Fig. 7.)

If a scar is very large, however, as after

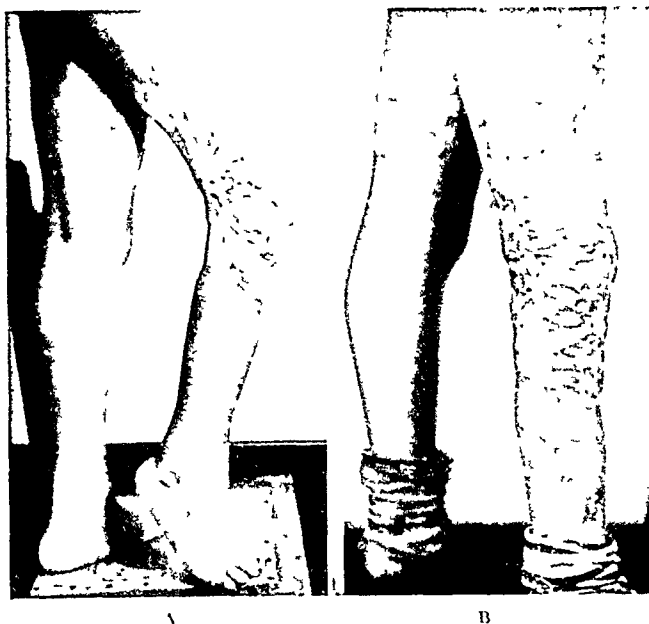


FIG. 8. A, large contracted scar of right leg. B, same patient eight months after division of binding web of scar, correction of contraction and skin grafting of defects.

is one of the most difficult problems in plastic surgery. The extensive contracted scar is usually caused by destruction of the deeper parts of the surface tissue, and appears usually at the flexor surface of the extremities or at the junction of limb and trunk. In some cases much can be done to avoid them to a greater or less degree by proper immobilization of the affected limb during the healing stage. Before any operative correction is undertaken, one should wait until the scar tissue has reached its final stage, although waiting too long may cause joint ankylosis and shortening of tendons and ligaments. Active and passive motion exercises of the affected limb during the waiting time is advisable. The objects of treatment are to remove the scar, to replace it by normal tissue, and to restore function. The scar must be removed entirely until normal tissue is exposed; only then can contracture be overcome. The defect is covered by a skin graft or pedicled flap, the proper choice of which is dictated by the local

extensive burns involving the entire thigh or leg, it is inadvisable to remove the whole scar as it would be impossible to obtain sufficient skin with which to cover the defect. To relieve these large, thick, contracted, adherent scars, Davis<sup>1</sup> advises relaxation incisions. The contracted portion is stretched and the most binding area or areas are located and marked out. The scar is divided completely until normal tissue is reached. Sometimes radiating incisions from the tight margins are necessary to complete relaxation. If, after the relaxation incisions are made, the scar is found to be very thick, Davis advises excision of a wedge-shaped slice of the deeper layer so that the thinned surface edges may be drawn downward and attached to the normal base by a few sutures. The defect is covered primarily or secondarily with skin grafts.

If the cicatricial area is too extensive the procedure should be done in stages. In the case represented in Figure 8 the binding web was so long that two relaxa-

tion incisions were necessary. The edges of the defect created after the incisions were unusually thick— $1\frac{1}{2}$  inches. Although slices of the deeper tissue were excised and the surface edges attached to the normal base, yet the defect remained quite deep. The defects were covered with split grafts which, however, partly sloughed away, particularly at the edges. The leg was immobilized in a plaster case for four weeks. After this time granulations had filled out the entire defect, had raised the surviving parts of the grafts from which epithelization spread over the granulating surface with resulting healing. (Fig. 8.) The same relaxation incisions are recommended by Davis for so-called unstable scars where healing is very poor.

#### SUMMARY

The plastic repair of scars is discussed under two headings: correction of simple scars and correction of extensive scars. Both types can be smooth, hypertrophic, depressed or contracted. Suitable methods of repair are described for each type of scar.

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# CORNS—THEIR ETIOLOGY AND TREATMENT

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GALLAND<sup>1,2</sup> and Lapidus<sup>3</sup> have shown that the effective treatment of a persistent painful corn depends upon

Toes with normal relationships between their component parts and with other toes do not develop corns. Shoe pressure is

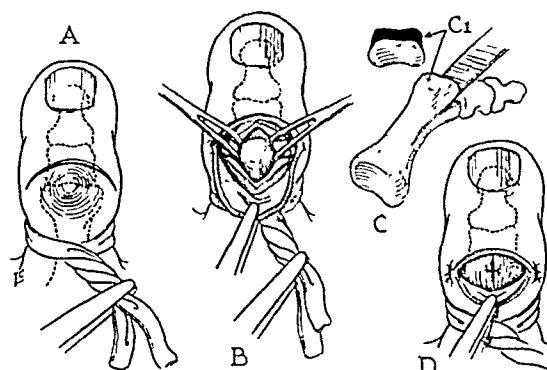


FIG. 1. Illustrates the method of dealing with the dorsal corn.

an appreciation of the basic cause underlying the development of the corn.

## ETIOLOGY

A corn is produced by a shoe which causes friction and pressure on the skin of a toe at a point where a bony prominence underlies the skin. Roentgenograms may show a definite exostosis, but more commonly the bony prominence underlying the corn is seen to be a prominent portion of some normal bone structure. The etiology, then, is similar to that of bunion.

Toes presenting corns are either cocked-up, flexed at the phalangeal joints or exhibit a varus or a valgus deformity. All of these abnormalities, slight as they are in many cases, accentuate the normal points of bony prominence which function as pressure points between the toes themselves or between the toes and the close-fitting shoe. About these prominent portions of bone soft tissue reactions occur which lead to fibrotic changes and corns develop. Many corns have accompanying bursae between them and the underlying bone.

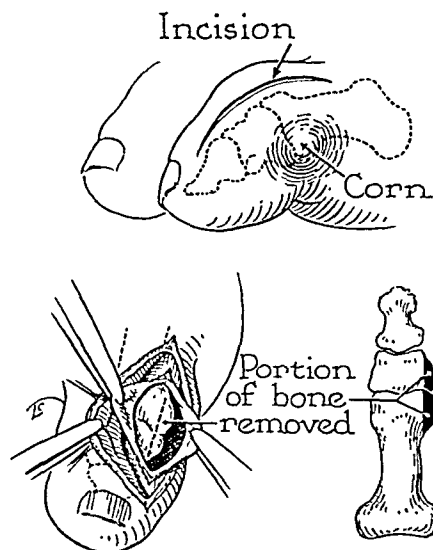


FIG. 2. Illustrates the surgical approach and the portion of bone removed in dealing with the common fifth toe corn.

applied evenly over the entire surface of these toes. No one point takes the brunt of the shoe pressure.

## CLASSIFICATION OF CORNS

**Hard Corn.** This corn is characterized by a horny induration and thickening of the skin on an exposed part of the toe. It may vary in appearance from the large clavus with a definite conic center to the extremely vascular corn which the slightest trimming will cause to bleed profusely. The common sites for this corn are over the dorsum of the second to the fourth toes and over the dorsolateral surface of the fifth toe. The usual location is over the dorsum of the proximal phalangeal joint, but this corn is found at times over the distal joint as well.

**Soft Corn.** This corn appears between the toes and exhibits more or less macera-

tion due to moisture. Two varieties are noted:

A. *The Phalangeal Joint Corn.* This is

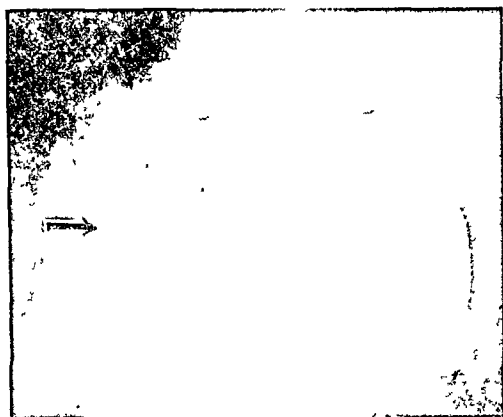


FIG. 3. Roentgenogram showing exostectomy site for fifth toe corn. Compare with Figure 2.

present over a bony prominence on the lateral or medial side of one toe and has its counterpart on the medial or lateral side of the adjacent toe. The common sites for this corn are between the most lateral three toes in the region of the proximal phalangeal joint. (Fig. 4.)

B. *The Phalangeal Base Corn.* This corn is not uncommon. It may be extremely painful. It is situated deep in the web between two toes. It is caused by a prominent phalangeal base of the proximal phalanx of one of the toes. The base of the phalanx is made prominent by a fixed dorsal extension of the toe at the metatarsophalangeal joint. This produces an abnormal relation of the base of the phalanx to the toe next to it, and pressure results. The most common site for this corn is between the fourth and fifth toes. When present in this location, it is caused by a prominent lateral portion of the base of the proximal phalanx of the fourth toe. (Figs. 5, 6, 7, 8 and 9.)

#### TREATMENT

*Shoes and Stockings.* Palpation of a corn with the toe in its unrestricted position will reveal the underlying bony prominence if the deformity is fixed. If the deformity of the toe is not fixed, the

prominence may not be present except when the foot is enclosed in a stocking which is too short or in a shoe which does

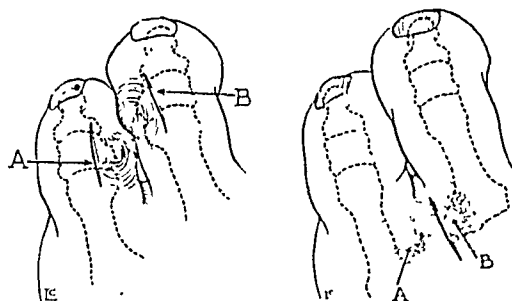


FIG. 4.

FIG. 4. Illustrating the phalangeal joint corn and the incisions used.

FIG. 5.

FIG. 5. Illustrating the phalangeal base corn and the incision used to split the web and expose the prominent phalangeal base.

not fit the foot well. In either case, the toe will be thrown into an abnormal position, and a corn will develop at the point where the greatest contact pressure is applied. The simplest and the most effective treatment for many corns is correctly fitted shoes and stockings.

*Sole Wedges.* A painful corn on the dorsolateral side of the fifth toe is relieved at times by a small outer sole wedge.

*Adhesive Plaster and Mole Skin Pads.* These pads when applied directly over the corn relieve friction and prove adequate in many instances.

*Felt Pads.* Commercial pads are usually in the form of a ring which surrounds the corn. Many corns are better treated by a simple felt block placed proximal to the corn. One way to apply the block is to cut a piece of good grade felt in the shape of a signet ring. This block is easily adjusted to slip over the toe with the block just behind the corn. This block is applicable to both the hard and phalangeal joint corn. The phalangeal base corn is at times relieved by a small metatarsal pad placed just behind the metatarsal head of the offending toe. This pad may correct the extension deformity and thus relieve the pressure.

*Paring and Skiving.* This treatment is best carried out by a skilled chiropodist.

When this form of treatment is performed on correctly selected patients, it offers temporary relief. Patients with diabetes

patient is relieved of both the pain and the corn.

Persons seeking relief from pain sufficient



FIG. 6. Arrow indicates prominent phalangeal base. Same case as Figure 7



FIG. 7. Arrow indicates operative site. Correct amount of bone removed. Note that exostectomy of first and fifth metatarsal heads has also been done.

or who have evidence of inadequate circulation in the feet should not be chosen for this form of therapy.

*Operative Treatment.* The only way for a patient to obtain permanent relief from

for them to accept operation should be free of diabetes and should have adequate circulation of the foot and toes. Further,

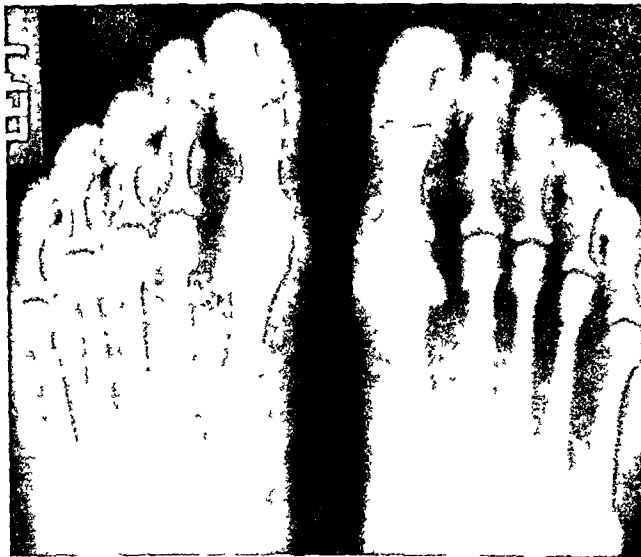


FIG. 8. Illustrates prominent phalangeal base fourth toe, bilateral

a painful corn in the face of persistent wearing of tight shoes, is by having the underlying bony prominence removed. If the bony point is adequately removed, the

the fixed deformities of the toes must be mild. For severe toe deformity other procedures than simple exostectomy are indicated.

## OPERATIVE TECHNIC

*Preparation of Field.* (1) The foot is prepared the night before by shaving the

is carried through the skin. The expansion of the extensor tendons and the digital arteries should not be cut. The skin flap

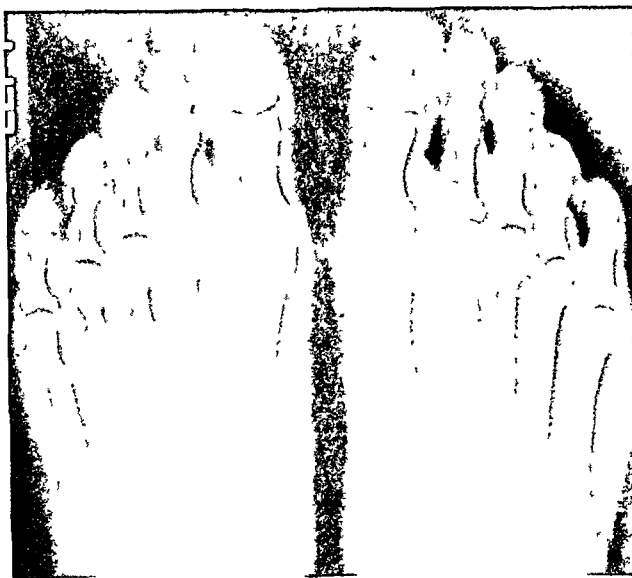


FIG. 9. Same Case as Figure 8, three years after operation. Exostectomy too generous, but no dislocation has occurred. Note protective pad worn for corn on fifth toe, left, which appeared after surgery. This corn is due to slight varus deformity of the fifth toe, which developed due to the medial subluxation of the fourth toe at the metatarsophalangeal joint. This subluxation results from too generous removal of the phalangeal base.

toes and then cleansing the foot with soap, alcohol and ether. A sterile dressing is applied. At operation an ether-iodine ritual is observed. (2) The toe to be operated upon is exposed and the distal portion of the toe is covered by a rubber cot. (3) The base of the toe is injected with 1 per cent novocaine. (4) When feasible, a rubber band is placed about the base of the toe and its ends are caught by a hemostat. The hemostat is twisted until a tourniquet effect is obtained. If this method is followed, it is virtually impossible to leave on the tourniquet inadvertently.

*Hard Corn.* The bony prominence commonly is formed by the dorsal portions of the condyles of the phalanx proximal to the joint. At times the dorsal portion of the base of the phalanx distal to the joint is also a factor.

The incision for the dorsal corn is a small U-shaped incision which develops a flap with a wide base proximally. This incision

is turned back. The dorsal expansion of the tendons and the joint capsule are split longitudinally and in the midline. These structures are raised by means of a periosteal elevator or a small chisel and are retracted to their respective sides. This will expose the condyles and the adjacent joint cartilage. Gentle handling of the skin flap is observed throughout the operation.

The bony prominence which is the complete dorsal surface of the condyles is removed with a small chisel. The exostectomy site should be trimmed until the surface has rounded sides and a flat top. With the toe in its accustomed degree of flexion, the adjacent portion of the base of the phalanx should be flush with this new surface. If this is not the case, the exostectomy site or the base of the phalanx is trimmed until this condition exists.

The capsule and then the expansion of the extensor tendons are brought together and sutured. The skin flap is sutured in

place. The tourniquet is removed, and the toe is bandaged in as much extension as possible. (Fig. 1.)

The prominence on the fifth toe is reached through the incision as shown in Figure 2. The prominence here is often formed by the dorsolateral surface of both the condyle and the base of the adjacent phalanx. In any case, the surface of the exostectomy site should be adequate, smooth and rounded so as to blend gradually with contiguous bone surfaces. Careful palpation through the skin before the wound is closed will reveal any overlooked prominence. If one is found, it should be removed. The base of the phalanx and the adjacent portion of the condyle must be made flush with each other. (Figs. 2 and 3.)

*Soft Corn.* The prominence of the *phalangeal joint corn* is usually on one toe only, but a prominence may be on each of the involved toes. Palpation of the corns will reveal this fact. The incisions used are shown in Figure 4. The exostectomy must satisfy the same requirements as stated above.

The prominence of the *phalangeal base corn* is reached through a web-splitting incision which is made slightly towards the side of the prominent phalangeal base. (Fig. 5.) These wounds bleed profusely at times, but the exposure must be adequate so the exact amount of bone to be removed can be visualized. One-third of the expansion of the phalangeal base may be removed. (Figs. 6 and 7.) If more than this is removed, subluxation or dislocation of the toe may result. (Figs. 8, 9 and 10.) The wound is closed and the toe is bandaged in slight plantar flexion at the metatarsophalangeal joint.

*After Care.* (1) Allow walking to begin between the third and the fifth day. (2) Remove the sutures on the tenth to the fourteenth day.

*Remarks.* Curretting the corn is not necessary. The corn disappears in from three to four weeks after operation. It does

not recur. The scar becomes almost invisible.

Cutting out the corn by an elliptical



FIG. 10. Illustrates dislocation which will result if too much of the lateral expansion of the phalangeal base is removed at time of operation.

incision may make the closure of the wound difficult.

Amputation of a toe for an uncomplicated corn is not necessary. Other conditions may exist in the toe which call for amputation but not the corn itself.

#### SUMMARY

A corn is produced by a shoe which causes friction and pressure on the skin of a toe at a point where a bony prominence underlies the skin. This pressure may be direct or it may be transferred to bony prominences between the toes. Palpation of the corn will reveal the prominence.

Conservative methods of treatment are presented. If these fail, operative cure of the clavus is described.

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# A NEW TYPE OF DRESSING FOR BOILS AND CARBUNCLES

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A RELATIVELY noncontaminating and painless type of dressing for boils and medium-sized carbuncles, especially of the neck, buttocks and trunk, has been devised.

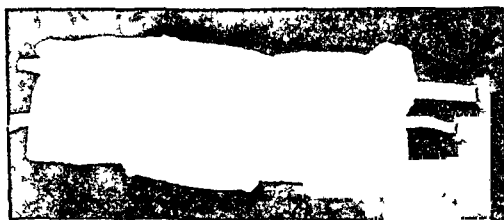


FIG. 1. Inner view of the prepared dressing.

pad. The bundle of smaller gauze pads is held in place on the 3 by 9 inch gauze pad by means of four adhesive tabs, three-fourths to 1 inch in length and one-third inch wide. The 3 by 9 inch dressing, which is the retaining dressing, is held in place by means of two pieces of adhesive, one-third inch wide and ten and one-half inches long. The ends of the adhesive that hold the dressing to the skin are thus only three-fourths of an inch each, in length. The ten and one-half inch strips are placed with their outer edges about three-fourths of an



FIG. 2. Typical infection of the neck, which had been treated previously by an old type dressing. The upper incision is over the original carbuncle. Note the lower incision over the secondary boil, which had formed as a result of contamination of an opened hair follicle.



FIG. 3. A three quarter view of the applied dressing. Note the distance from the site of infection to the point of attachment of the adhesive tape.

The dressings are easy to make (Fig. 1) and to change. They are constructed by putting from two to four 3 by 3 inch gauze pads on the center of a 3 by 9 inch gauze

inch from the outer edges of the retaining dressing.

The skin over the area where the adhesive is going to be fixed is shaved with an

electric razor and cleansed thoroughly with benzene and alcohol before the application of the first dressing. The dressing is then applied over the center of the infection. (Fig. 2.) The inferior strip of adhesive (Fig. 3) is pulled rather tightly.

Each time the dressing is changed (once or twice daily), the area is cleansed with a solution of 1 dr. of salicylic acid to 4 ounces of spirits of vini recti. Any small secondary pimples are painted with one half strength tincture of iodine. Any hypertonic, aqueous based ointment may be used on the boil or carbuncle.

There is less danger of contamination of the surrounding skin, for the following reasons: The hair follicles, which are opened by the removal of the adhesive, are situated some distance from the site of

infection and therefore do not tend to become infected. The pus is confined to a more limited area by the use of the bundle of gauze squares than if a larger dressing were used. Contamination of the skin, due to gravity drainage of the pus, is diminished by having the inferior strip of adhesive drawn quite tightly.

There is a hypersensitivity of the tissues about the infected area, and movements of the head cause a very painful tension on the skin and hair with the ordinary dressing. This new type of dressing is much more comfortable. The attachment of the tape to the skin is some distance from the inflammatory zone and is on an area from which the hair has been removed with an electric razor. For the same reasons, removal of the tape is relatively painless.



# ELECTROSURGERY

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THE practical application of surgical diathermy is a matter of correct technic. Fortunately, this technic is not complicated. The considerations which form the basis for the application of medical diathermy hold equally true for surgical diathermy. The essential difference is the fact that in surgical diathermy sufficient heat is developed to cause an actual destruction of tissue. The method may be varied in essentially four different ways. These are called fulguration, desiccation, coagulation and the application of the electric cutting current.

## FULGURATION

In *fulguration* the current is permitted to arc from the point of the needle to the surface which is to be destroyed. The action of this procedure is superficial. Only a very thin layer is destroyed. In order to cause the current to create a spark between the tip of the needle and the treated surface of the body, two different technics may be used. In the one, the needle held in a holder is connected directly to the Oudin terminal of the machine. In the other, a metal plate is attached to one terminal while the other terminal is connected to the needle. When using the monoterminal or Oudin technic, care must be exercised not to employ too much current or else arcing will occur between the electrode in which the needle is inserted, or the electric cord connecting it to the machine and the hand of the operator. The size of the arc occurring between the needle and the surface will naturally depend upon the distance at which the needle point is held. The limit of the distance across which arcing will occur will in turn depend upon the voltage of the current. There is no object in holding the needle away at any great distance. The usual distance is about one-eighth inch.

Fulguration is much less employed than it has been in the past. It is used only for the destruction of superficial lesions, for instance, port wine marks. Fulguration may be used in the treatment of other conditions where dermatologic practice of today employs medicinal solutions for the superficial destructive purposes. The advantage of employing fulguration instead of these medical escharotics is that the area to be destroyed can be much more exactly limited. The cosmetic results are excellent. It is usually impossible to detect where the destructive action of the fulgurating current has been applied after the destroyed layer is separated off. This separation occurs about ten days after fulguration.

## ELECTRODESICCATION

Electrodesiccation is particularly well suited for the destruction of small growths in various parts of the body. The current employed is that secured from the Oudin terminal of the diathermy machine. The settings are usually arranged so that the handle of the choke coil is placed at No. 1, i.e., where the smallest amount of current enters the machine. Where multiple spark gaps are present, usually only one or two are opened. The purpose of arranging the setting as described is to diminish the current, otherwise with its high voltage it may pass directly from the cord and needle holder to the operator. The essential difference in the technic of the application of desiccation as compared with fulguration is in the fact that in desiccation the needle is inserted into the growth to be destroyed before the current is turned on. As a matter of fact, some degree of fulguration also occurs at the same time because as the area becomes dehydrated arcing occurs between the needle and the tissue immediately surrounding it.

Electrodesiccation may be applied with the direct or indirect technic. In the former the needle is connected directly to the Oudin terminal.

*Indirect Technic.* In indirect technic the patient is connected to this terminal usually by means of a metal bar which he holds in his hands, or else he may be placed on an autocondensation chair or he may lie on an autocondensation pad. The operator then inserts the needle which he holds in his hand into the lesion. He must be careful not to touch any portion of the patient's body or else he will draw the current away from the patient at the region which he touches. It is possible, too, that if the touch be a light one, arcing will occur with an unpleasant sensation both to the patient and to the operator. This indirect technic is only of value when the area to be destroyed is small in its extent and in its depth. If applied carefully, it may be employed without the use of any local anesthetic.

*Direct Technic.* The most commonly employed technic is the direct one. The action of the current may be intensified if the patient is grounded. This is accomplished by permitting the patient to hold a metal rod which is connected by means of a wire to a waterpipe or a steam radiator. A variation of this grounding technic is one in which a metal ring is held by the operator surrounding the region into which the desiccating needle is inserted.

It is always best to use a local anesthetic when applying any variety of surgical diathermy. These applications are painful, so that if the area is not desensitized by means of a local anesthetic, the patient is apt to move the part away quickly. This motion may be beyond the control of the patient.

There are many advantages in the employment of electrodesiccation for the removal of superfluous growths. The important consideration, from the point of view of the patient, is the completeness of removal without the subsequent detection by any observing eye of any evidence that

things were not as nature meant them to be in that area. Electrodesiccation fills this requirement very well. For this reason it is well suited for the removal of growths on the face.

An additional advantage is the extreme exactness with which tissue may be destroyed. This makes the technic particularly applicable for the destruction of areas about the eye. Xanthoma, for example, may be removed by electrodesiccation. If the destructive action has not been sufficiently thorough, it is a simple matter to desiccate the area again at some subsequent period. Small cysts about the eye lend themselves well to the destructive action of the desiccating current.

In treating villous papilloma all that is necessary is to apply the desiccating needle to the tips of the villae. It will then be observed how these finger-like projections become white under the application of the current to the base from which they arise. This type of action holds true for all pedunculated growths, because the current concentration is more or less equal throughout the extent of the pedunculated growth up to its base. Pedunculated polyps can be similarly treated. Corneal ulcers may be desiccated or fulgurated. Granulations on the conjunctiva may be destroyed in like manner.

A third advantage of the use of electrodesiccation is its prevention of bleeding. This is particularly useful in the removal of growths in vascular areas. For tumors in the mouth the use of desiccation is ideal. Papillomas on the tongue may be readily destroyed. The area is first desensitized by topical application of a mucous membrane anesthetic such as a 10 per cent solution of cocaine. Desiccation is then accomplished within a few minutes.

The dehydrating action of this current is valuable for the desiccation of epulis involving only the mucous membranes, and also other growths on the inner side of the cheek, on the uvula and on other regions of the buccal mucosa. Some operators have applied electrodesiccation for the removal

of tonsils. This is a slow method for the removal of these organs. The question of tonsil destruction by means of the electric current will be discussed subsequently. The most common condition for which electrodesiccation is employed is for the removal of verrucae. All varieties of warts can be destroyed by this agency. A few drops of 1 per cent or 2 per cent novocaine are injected into the region surrounding the wart. The desiccating needle is inserted in the growth and the current is turned on by means of a foot switch. The region around the needle is observed to blanch. The current is permitted to flow for a period of about two or three seconds. It is then discontinued, the needle is withdrawn and reinserted into an adjacent part. This process is repeated until the entire growth has been desiccated as evidenced by a change in its color. The tissue turned white by the action of the current will separate away in about two weeks. During that time the region underneath this cover of destroyed cells is preparing to take on the function of acting as a new surface. As a rule, a temporary discoloration appears after the crust of dead tissue separates off. Occasionally this region may assume a pink color which may last for months before it eventually fades.

#### ELECTROCOAGULATION

Electrocoagulation causes more intensive destruction than electrodesiccation. It is, therefore, the type of current best applied for the destruction of a malignant tissue. It is also employed for the removal of benign growths which are too large to permit the use of the desiccating current. It is the type of high frequency current most widely employed for destructive purposes. Essentially the same hook-up is used as in medical diathermy. The major difference consists in the fact that the current is strongly concentrated at the area which one desires to destroy.

*Technic.* The technic usually followed consists in applying a large electrode to any part of the patient's body. This electrode is

connected to one terminal of the d'Arsonval winding. The other terminal is connected to a very small electrode. The large electrode has been called the inactive one because no major demonstrable change occurs in the tissue beneath it. It is better called the "dispersive electrode" to indicate that the current applied through it is spread over a large area.

The small electrode is called the active one. It is most often a needle. It may be a small metal ball or flat disk, or, for that matter, of any other shape. The flat disk electrodes were among those first used by that pioneer in electrosurgery—Doyen. They have been generally discarded because it is difficult to determine the depth to which the tissue beneath them is destroyed when the current is turned on. It is true that they cover a larger surface than do the needle electrodes, but by means of multiple punctures these latter electrodes can be made to cover as large an area as desired and with much better control of the destructive action. The ball-tipped electrode is usually applied to surfaces where it is desired to stop bleeding from oozing vessels or from a frank bleeder.

When employing the large dispersive and active electrode technic, the electromotive lines of force may be presented as a cone with its apex at the active electrode and its base at the dispersive one. The greatest concentration of current is, of course, at the very tip. There is sufficient concentration of current, however, at a short distance away from the tip to cause destruction of tissue. Beyond this, there is an area where the heat produced is not sufficient to cause an actual destruction but only temporary irritation. In this manner the coagulating effect gradually fades away from the point of the electrode. The depth to which the tissue is destroyed varies with the current strength, the time interval during which it is permitted to flow and with the electrical resistance of the tissues.

The question is usually asked, "How much current shall I use to coagulate tis-

sue?" The best answer is that the questioner experiment with the settings on his own machine while applying the current to a piece of meat. It is possible to answer this question more definitely, as, for example, by saying that such an amount of current should be used as will give a reading of 2000 milliamperes on the hot-wire meter of the diathermy machine when the current is short circuited through the machine. In doing this, the needle connected to one terminal of the d'Arsonval coil is applied directly to the other terminal with the current on. Such a definite answer may be misleading, so that it is far better to acquaint oneself with the factors of current strength and the time period of flow first on a piece of excised tissue (meat) and then on the patient. I do not employ the meter on the machine when applying surgical diathermy for two reasons. One is that, as indicated, the reading on the meter is of little value. The other is to avoid the danger of burning out the meter by accidentally short circuiting it.

The color of the tissue changes to white as it becomes coagulated. This helps to indicate the extent of the destroyed area and serves as a better guide than any definite rule as to the amount of current to be employed and the length of the time during which it is permitted to flow. The coagulated areas will surround the needle and also extend for some distance beneath it. The extent of this distance can best be predetermined by experiment and by experience.

Instead of using the dispersive active electrode technic, it is possible to use two active electrodes, as in my special electrosurgical clamp. The electric current then becomes essentially limited to the plane of tissue lying between the active electrodes. The current does not restrict itself to a straight line connecting these electrodes but also bends outward somewhat, so that the current action is not absolutely confined to the region lying between the electrodes. This principle, however, does permit of a more exact limitation of the

destructive action of the current than does the dispersive-active electrode technic.

There are many specially shaped electrodes manufactured to apply surgical diathermy to various parts of the body, as in the nose, throat, urinary bladder, cervix and in other places. All these electrodes are constructed on the principles mentioned. Recently I have had built a surgical electrode surrounded by a hollow tube of insulating material. Suction produced within this tube holds the tissue to which the open end is applied against the coagulating electrode. I have found this electrode particularly valuable in destroying tissue inside of the oral cavity.

The histologic change occurring in tissue during electrocoagulation is the production of hyalinization. Examined through the microscope the tissue is one homogeneous mass. One is not able to differentiate cell protoplasm, cell membrane and the nucleus. This histologic picture has been described by W. L. Clark. He differentiates it from that occurring during electrodesiccation. In the latter, he states that dehydration occurs with mummification of the cells. The identification of cell membrane and nucleus is maintained. Our own experience serves to indicate that the character of the histologic change depends upon the intensity of the current concentration rather than on its special characteristics. A mild coagulating effect will produce a histologic change resembling that described in electrodesiccation, and a strong electrodesiccation will produce a hyalinization of tissue like that described as occurring during electrocoagulation.

*Electric Cutting Current.* A modification of the high frequency current secured from diathermy machines permits of the cutting of tissue. For this purpose a needle electrode is usually employed. The other terminal on the machine is connected to a dispersive electrode placed anywhere on the body. To the uninitiated it is astonishing to see how a dull needle edge supplied with this current may cut through a piece of meat as if it were a very sharp instru-

ment. The actual cutting effect is secured from the application of the high frequency current. Exactly how has not been determined. The great advantage as compared with the usual surgical scalpel lies in the fact that the tissues on either side of the incision can be coagulated as the cut is made. By changing the settings on the machine the depth of this coagulation can be varied from a thickness of 1 or 2 mm. to several times this number.

In using this technic it is important to cut only with the needle point. All too frequently the surgeon trained in the use of the usual scalpel will attempt to cut with the side of the needle rather than with its point. This does not permit of sufficient current concentration and therefore gives a very unsatisfactory cutting action.

The wall of coagulation formed as the incision is made is sufficient to produce hemostasis of the capillaries and of the small blood vessels. The action of the current is not sufficiently hemostatic to prevent bleeding from the larger blood vessels. These can be tied off by means of a ligature or they may be seized in the jaws of an artery clamp to which the high frequency current conveyed through the needle electrode may be applied. A second of current flow is usually sufficient to cause coagulation of the tissue held within the grasp of the forceps.

If there is some bleeding, coagulated blood may adhere to the needle electrode. It should be removed promptly or else there occurs a marked diminution in the effectiveness of the application of the cutting current. To accomplish this, an excellent procedure is to stick the needle into a wire sponge such as the type sold in hardware stores for the cleansing of pots and pans. Another method is to scrape off the coagulum from the needle by means of some instrument like a forceps. Wiping with a piece of gauze is usually not sufficient because the coagulated blood adheres too firmly to the needle.

The cutting current may be employed by itself or in conjunction with the other

modifications of surgical diathermy such as electrodesiccation, and, more particularly, electrocoagulation. This latter combination of the cutting and coagulating currents is the most effective for the surgical removal of new growths. The cutting current cannot be secured from the ordinary diathermy machine. It may be incorporated as a special addition to the diathermy machine or may be purchased as a separate unit. The earliest types of diathermy machines made to cut employed the three elements of the vacuum tube. However, for the past several years, machines making use of the spark gap have been on the market and have proved to be very efficient. They may not give as narrow a zone of coagulation below the cut surface, but to all intents and purposes they appear to be just as efficient. As a matter of fact, the criticism which has been made against the tube machines is that they do not produce as wide an area of coagulation as is frequently desired when employing the cutting current.

Some surgeons are using the electric cutting current even for incising the skin. The great majority of surgeons using surgical diathermy seem to prefer the scalpel for this purpose. The first group of surgeons claim that they can secure primary union in incisions made by the cutting current. The general impression appears to be, however, that to secure primary union the surgical scalpel is the preferable instrument.

When he thoroughly understands the principles involved in the application of electric coagulation and the electric cutting current, the surgeon will soon learn to understand to what lesions he may apply this combination in preference to the use of the scalpel and scissors. These lesions may be either benign or malignant.

The surgeon will employ surgical diathermy for its hemostatic action, for its greater effectiveness in the destruction of malignant tissue, for the ease of its application, for its good cosmetic after effects and for its sterilizing influence.

The hemostatic action of electric surgery makes it particularly applicable for the treatment of conditions developing in vascular tissue. Thus it has greatly broadened the scope of the brain surgeon. It has simplified the cutting of kidney and liver tissue. In gastrointestinal surgery it has the dual advantage of hemostasis and bacterial sterilization. This is of special value when cutting through such tissue as the large intestine in operations for carcinoma.

In the mouth the cutting current is peculiarly effective. Tumors of the oral mucosa may be readily removed without the production of bleeding. This was well illustrated in a case treated by me where sarcoma metastasis in the gums so completely buried the incisor teeth as to make mastication impossible. The friable tissue of the new growth was readily removable with merely a little oozing. The operation for carcinoma of the tongue has been simplified by the application of coagulation and the cutting current. Epulis involving the mucous membrane is another oral condition which is relatively easily handled by coagulation, in contrast to the bleeding which may be controlled only with great difficulty, as many an oral surgeon knows. New growths in the neighborhood of the mouth, such as those appearing on the lip and on the face, are well suited for the application of electrosurgery.

There exists considerable controversy as to whether surgical diathermy or the more usual surgical methods should be employed for the removal of tonsils. There are some who feel that surgical diathermy is the method par excellence; while many others, particularly nose and throat specialists, claim that surgical diathermy has no place in the removal of tonsils. There is no question but that tissue anywhere may be removed by surgical diathermy. The exact application for the destructive action of this procedure to tonsils requires a knowledge of anatomy and of surgical technic which the general practitioner does not usually possess. For the routine case, the

usual surgical enucleation of tonsils by a competent specialist is the method of choice. Where contraindications to this technic exist, surgical diathermy may be applied, as for example in cases of hypertension, hemophilia and cardiac diseases, tuberculosis, etc.

For the removal of hemorrhoids surgical diathermy offers an extremely valuable technic, which has many points of superiority when contrasted with other forms of surgery. The hemorrhoidectomy may be performed in the office. There is no bleeding or danger of infection. The after pains appear to be less as also the period of incapacity. For the performance of this operation the ordinary active electrode and dispersing electrode may be employed or else the special two active electrode clamp. The use of this latter instrument facilitates the coagulation of the tissue at the base of the hemorrhoid. In surgical diathermy heat is developed within the tissues by the passage of the high frequency current. In cautery, the heat is applied from the external source. The physical action of these two procedures is entirely different.

*Electrosurgery of the Genitourinary Tract.* One of the first uses to which electrocoagulation was put was for the destruction of growths in the urinary bladder. Edwin Beer coagulated such growths many years ago. An indication of the flexibility of the procedure is the fact that these growths in the urinary bladder may be destroyed by the aid of instruments inserted through the urethra. A flexible electrode with a ball tip is inserted through the operating section of the cystoscope. It is bent in any desired direction by means of the deflecting device of the cystoscope so that it may be brought into contact with the growth which is to be destroyed. For the destruction of benign growths this is an excellent method. For the treatment of malignancy, however, many urologists prefer to do a suprapubic cystotomy and then to coagulate all the evidences of malignant growths *en masse*. This treatment may, of course,



be combined with the application of radium and of x-rays.

During the past few years a new application of surgical diathermy has been made to the urinary tract in the male. This consists in the removal of prostatic tissue obstructing the bladder neck. The extent to which hypertrophy of the prostate may be treated in this manner is still undetermined. There are some urologic enthusiasts who believe that lateral lobe intrusion may be cut away as well as that of the median lobe. The electric cutting current is the one employed for this purpose. It is applied by means of a specially constructed wire loop which is operated through a special urethroscope. The one danger of this operation is the occurrence of postoperative hemorrhage. To avoid this, it has been suggested that a current giving a heavier degree of coagulation than that secured from the tube machines be employed. Although there may be some question as to the extent to which the cutting current may be applied for the removal of prostatic intrusion, there appears to be a consensus of opinion amongst those urologists who have used this method, that it is of extraordinary merit in the removal of median bar and median lobe intrusions. The whole situation is in a state of flux. After it has been more thoroughly developed, it is possible that we may find that urology has made a brilliant advance in simplifying and making safe an operation which is the dread of the many men who require prostatectomy.

Urethral caruncle is a condition which well illustrates the hemostatic advantages of surgical diathermy. It is relatively easy to destroy this by means of electrodesiccation or electrocoagulation. The skilled urologist may also apply surgical diathermy by means of a long, insulated electrode passed through a urethroscope to destroy the glands of Littre. In the female, Skene's glands may be more readily destroyed so as to kill any gonococci which may be existing there. This action illustrates the sterilizing advantages of the

application of surgical diathermy. The glands of Bartholin may be similarly destroyed when they are abscessed. An incision may be made with the cutting current through which a ball electrode may be inserted and the entire lining of the gland coagulated.

The cervix uteri is another area of the body which when diseased serves to illustrate well the advantages of the application of surgical diathermy. Carcinoma of this part of the body may first be coagulated and then removed by the cutting current, to be followed by the application of radium or x-ray. It is in the treatment of chronic endocervicitis that surgical diathermy has shown brilliant results. The diseased portion of the endometrium may be removed by means of the current applied through a special loop, or the region may be coagulated in narrow strips. By this means, a condition which formerly required the hospitalization of the patient and the performance of an amputation of the cervix may now be more satisfactorily treated in the doctor's office.

*Electrosurgery of Malignant Condition of the Skin.* It is in the treatment of malignancy involving the skin that surgical diathermy first clearly demonstrated its many advantages. A technic commonly employed is to surround the malignant area with a wall of coagulated tissue. This circumvallation, as it has been termed, is done by inserting the active electrode needle into the healthy tissue surrounding the growth. The current is turned on so as to coagulate the region around the needle. This instrument is then withdrawn and reinserted into the area immediately adjacent. To get underneath the growth a curved needle is used. The result of this technic is to surround the new growth with an area of coagulation extending well into the normal tissue. The malignancy is then removed by means of the cutting current. The advantage of destroying malignancy of the skin by this technic lies primarily in the fact that the danger of the spread of the new growth is greatly minimized

when compared to the employment of the scalpel and scissors. Another advantage is the absence of bleeding, and a third is the subsequent good cosmetic result. Electrocoagulation may, of course, also be used for destroying benign growths and other conditions such as lupus vulgaris. The hemostatic action of the current makes it particularly applicable for the destruction of vascular growths such as angioma.

Electrocoagulation and the electric cutting current are employed for the eradication of malignant growths not only on the skin but in other areas of the body, such as in the breast. These agencies may or may not be used in conjunction with the scalpel and scissors for the initial skin incision and for the dissection of involved lymph glands. This holds true of the treatment of malignancy in other organs. The subsequent application of radium or x-ray is a common form of after treatment.

*Electrosurgery by Means of the Direct (Galvanic) Current.* If the action of the galvanic current is concentrated, it is possible to cause destruction of the animal tissue by its use. The negative pole is usually employed for this purpose. This method has been used in the past for the destruction of growths, but it is employed almost exclusively today for the destruction of hair follicles. Surgical diathermy is being used for the same purpose. A great majority of individuals practicing epilation, however, employ the galvanic current. This current is best derived from a battery so as to avoid the irregularities of current

flow when the house current serves as the electric source.

A fine steel needle is connected by means of a cord to the negative pole. The positive pole is attached to a large dispersive pad which may be placed on the patient's back as she lies on the table or to any other part of the body. Good light is essential so as to permit of catheterization of the hair follicle by means of the needle. The current is turned on by means of a hand or foot switch and about  $\frac{1}{2}$  to 1 milliamperes of current is permitted to flow through the circuit. Within several seconds it is usually possible to see bubbles appearing at the region where the needle presses the skin surface. The current is then discontinued. If the follicle is completely destroyed, it is possible to readily remove the hair much as if it were stuck in butter. While the current is flowing, the patient experiences a disagreeable sensation. She does not feel the actual removal of hair if the follicle has been destroyed. The destructive action of the current is exercised through the production of an alkaline solution at the region of the needle contact. The area of the chin is less sensitive than the region around the mouth. The upper lip, particularly in its section near the nose, is very sensitive. A reaction occurs to this operation. It is therefore inadvisable to remove too many hairs close to each other at one time as the erythema and swelling may become confluent. The epilation sessions should not be applied more frequently than about once in five days to the same area.



# THE EFFECTS OF RADIATION ON CANCER

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THE effects produced by x-ray and the gamma ray of radium on tumor tissue have been extensively studied grossly and microscopically. Such studies are, of course, more easily and exactly made upon transplantable laboratory neoplasms.

The changes seen microscopically after radiation of these tumors may be divided into several stages: First, slight hyperplasia; second, a latent period in which no apparent change takes place; third, the appearance of large numbers of abnormal cells, the abnormality being characterized frequently by a swelling of the cytoplasm; fourth, cell death; fifth, replacement of these cells by polymorphonuclear leucocytes and young connective tissue cells; and sixth, scar formation with the inclusion of tumor cells of diminished vitality.

It has been regularly found that young cells, which are actively dividing and particularly those which are undergoing mitosis at the time of exposure to x-ray, are more profoundly effected than the more adult type of cell. For this reason moderate radiation of tumors before transplantation will often interfere with growth without interfering with the ability of the transplant to take.

Lacassagne has explained these varying reactions of tissues to radiation, as evidences of the effect of ionization on various parts of the cell complex. He explains that following irradiation of cultures of polytoma uvella the following reactions were observed on cell counts: temporary suppression of growth, abortive anomalies of division and suppression of reproduction. Temporary suppression of growth was observed to occur in most of the individuals, abortive anomalies of division in a much smaller number, and suppression of reproduction and, therefore, eventual death was

observed to occur least often. Volumetric estimates of the major cell elements of polytoma uvella were made and disclosed that the percentage volume of cytoplasm in each cell corresponded closely to the number of these organisms which showed a temporary suppression of growth after irradiation. It was also found that the percentage of cell volume occupied by chromatin and the much smaller volume taken up by the centrosome corresponded to the number of organisms, which on count after radiation showed abortive anomalies of development and suppression of reproduction, respectively. Lacassagne assumed from these results that damage to the cytoplasm which on a chance basis would occur most often, produced suppression of growth. Damage to the chromatin and the centrosome were likewise assumed to produce abortive anomalies of division and suppression of reproduction.

An accurate understanding of how and why these changes occur is very much more difficult to conceive, and since it is only by a practical conception of the mechanism of these changes that knowledge can be gained through which more profound tumor cell shock and death may be accomplished, it becomes necessary to attempt such an explanation.

We should first define just what radiation of the order of x and gamma radiation is, in what way are they similar and how do they differ? In attempting a practical understanding of these radiations, which are known to be of exceedingly short wave length and high frequency, an analogy to easily understood and more commonly encountered radiation is necessary. X-rays and the gamma ray of radium cannot be seen, felt or heard; they have no odor and they produce no temperature change. We

are, however, acquainted with many radiations which can be seen, felt or heard, and if we can establish in our minds an analogy between these radiations and those of x-ray and radium, we will have obtained a better idea as to the properties of all radiation. It will then be possible to postulate as to their behavior under various conditions.

The radiations with which we are best acquainted are those of long wave length and low frequency. Sound is perhaps the most easily understood, because of the fact that we can hear it, feel it, and in the case of the lower pitches actually see the movements of the generating body. We are able to study the wave form of these radiations by the attachment of a needle to the vibrating body and tracing its movements on a moving lamp-blackened paper.

Sound, as we all know, is produced by rhythmic vibrations of pieces of matter of such bulk and so fixed as to inherently oscillate at frequencies within the scope of auditory perception. This rhythmic vibration is usually caused by striking the matter to be used at a generator. The force with which it is struck determines the amplitude of the resulting wave. The frequency and wave length, however, are, as stated above, determined by the size of the mass and its fixation to surrounding matter. The larger the body and the looser the fixation, the lower the frequency or pitch produced by striking it; the smaller the body and the firmer the fixation, the higher is the frequency or pitch produced. When the body struck is so small as to set up vibrations which cannot be heard by human ears, the radiation so formed ceases to be called sound. As the bodies become smaller and smaller until we are setting in motion particles of the order of molecules, radiation of the order of radio waves, heat, light and ultra-violet are created. As single molecular groups, atoms, protons and their infinitesimally smaller electrons are set in motion, the inherent frequencies become more and more rapid, the wave lengths become shorter and shorter and the corresponding

radiations are known as grenz rays, soft x-ray, hard x-ray, the gamma rays of radium and finally the cosmic ray.

Presumably, all of the radiations belonging in the group known as x-ray, gamma ray and cosmic radiations are formed by the rhythmic vibrations of electrons, and the shorter the wave length and the more rapid the frequency, the more firmly fixed the generating electron must have been to produce them.

We, of course, have no organ of sense which can perceive radiations of greater frequency or shorter wave length than those of the violet end of the light spectrum. But by various indirect means we know that these radiations behave in a manner analogous to those which we can sense by one organ or another.

In the generation of waves of progressively higher frequency and shorter wave length, the body used as the instrument of percussion, must become progressively smaller as the bodies set in motion become smaller. Therefore, when electrons become the generating source, other electrons must be used to strike them. In the x-ray tube, electrons are created in a vacuum by disintegration of atoms in a wire filament as it is heated to incandescence. The greater the heat the more rapid is this disintegration, and the greater the number of electrons so made available. By impressing a high voltage negative charge on this filament and a positive charge on an adjacent dense metallic target, these electrons are driven across the space between the filament and the target and forcibly strike the atoms in this target. The impact of the bombarding electrons sets up radiation of varying wave lengths and frequency, depending upon the size and tension of the part of the atom which is struck, and the velocity of the bombarding electrons. The greater the electrical stress between the filament and the target, the more violent the impact between the electron freed from the filament and the electrons in the atoms of the target, the shorter is the wave length of the resulting radiation. However, the bom-

bardment also results in the formation of heat or infra-red rays.

In the case of radium (gamma) radiation, the bombarding electrons are freed in the atoms of radium because of their inherent instability, and the impingement of these freed electrons upon others creates the gamma radiation.

Now, in what way do these short wave length radiations affect living tissue, and particularly living, malignant tissue? Individual cells and some of their larger component parts are the smallest forms of tissue which we can see directly with a microscope. We know, however, that even the smallest visible parts are made up of a vast number of atoms which are, of course, ultramicroscopic. The structure of some of these atoms is simple, and of others, exceedingly complex. All are made up of a single nuclear mass with a varying number of surrounding electrons. Each electron has its own orbit about the nucleus in a way similar to that which exists in our planetary system, wherein each planet, analogous to the electron, describes its orbit about the sun, which is, in turn, analogous to the atomic nuclear mass. Some of these electronic orbits are more definitely fixed than others, and the more fixed the orbits and the greater the tension with which they are held to their paths, the more stable is the atom. It is obvious that any serious derangement of electronic orbits in these complex atoms changes the character and properties of the atom, and when the aberrations are carried far enough, or electron loss takes place, the atom loses its original identity and becomes a different element. When sufficient elemental changes have taken place particularly in critical portions of the cell, life ceases to exist.

In malignant tumor cells, which are growing and undergoing mitosis at short intervals, atomic and molecular rearrangements are continually taking place due to the necessarily rapid chemical changes which must accompany mitosis. In such cells a relative atomic instability is present, at least during the period of mitosis. On the

other hand, cells which are physiologically inactive are only occasionally undergoing mitosis and, therefore, chemical changes can be expected to be slower, and the whole cell complex more stable.

How does this variation in atomic structure, activity and stability affect the subject which we are considering, that is, the reaction of tumor cells to radiant energy?

Let us construct a relatively simple atom on a scale which we can readily appreciate. The electrons in this atom are moving along fixed orbits about the nucleus or proton group. The force holding the electron in its orbit determines the stability of the atom. Since the loss of one electron changes the orbits of others in the same atom and alters the number of component parts, the atom becomes another individual. Assume now that the electrons in an atom are suddenly confronted with an outside electromagnetic force, pulsating in character and timed to a frequency which would be the inherent frequency of one of these electrons, if it were struck by another body of like dimensions. The electron is immediately set into sympathetic vibration. If this vibration is sufficiently violent, the relationship of the electron to its orbit may be disturbed, and, in turn, if this disturbance is of sufficient magnitude, the force holding the electron to its orbit is overcome. In this event, the electron becomes a free agent, shoots off into interatomic space, may become a part of a neighboring atomic system or strike an electron or proton group in another such system. This impact sets up further radiation by producing oscillations of the body so struck. If forceful enough, the collision may dislodge the second electron and a second atom will be thus changed.

When a sufficient number of these changes have taken place, suppression of growth, disturbed reproduction or immediate cell death occurs, depending upon the particular intracellular structure which has been affected. It also follows that the conglomerate making up the cell is, the

more easily and quickly its destruction is accomplished.

In considering this subject and in building up these analogies, a much more simple concept of atomic structure has been assumed than that which actually exists. It may, however, be fairly said that no matter how complex one assumes atomic structure to be, and no matter how many other minute particles of matter are later found to make up the atom, the basic principles, as cited above, should still apply.

Having arrived at a workable explanation of radiation, and also a concept of the effects of radiation on living tumor cells, what is the clinical value of this data? It has been shown by experimentation, that a sufficiently large quantity of radiant energy will destroy any form of living matter. We can, therefore, assume that by the application of sufficient radiant energy we can effect the complete destruction of all malignant tumor cells regardless of their type, origin or biologic activity. We cannot, however, assume that in delivering this amount of radiant energy to a malignant tumor we will not at the same time destroy so much normal tissue about the malignancy as to cause the death of the host of the tumor. In any location where complete destruction of surrounding normal tissue can be accomplished without affecting vital structures, radiation can be expected to cure the cancer locally. Similarly, wherever a malignant tumor can be safely and completely excised surgically, a cure is effected. It is unfortunately the fact, however, that many cancers, particularly those which are deep-seated, either lie within, or are adjacent to structures so vital to the life of the patient, that the tremendous dosages of radiation which are necessary to the complete destruction of the cancer cannot be applied without at the same time destroying these vital structures. Similarly, it is often true that while the tissue in which the primary cancer tissue developed may be resectable surgically without destroying the individual, there

are microscopic or gross extensions from the primary site of the tumor because the extension involving these vital structures are not resectable. We should, however, remember that the extensions of the tumor cells into the lymphatic and other adjacent tissues are, of necessity, young, and, therefore, cells of a highly anaplastic, undifferentiated, rapidly growing and consequently radiosensitive type. In many instances we can destroy much of the local cancer metastasis with dosages well within normal tissue tolerance. Such reduced cancer involvement then becomes operable, and a cure can be accomplished by radical surgery in conjunction with reasonable amounts of x-radiation or radium radiation.

In explanation of the selectively destructive action of radiation on malignant tissue, we must assume that the cell which originally bore the malignant tissue was at its very inception a normal cell, and that for some reason unknown, it entered upon a career characterized by an unlimited power of multiplication. This characteristic was transmitted to its descendants, and as each succeeding generation appeared, the cell growth continued uncontrolled. At the same time, obeying in a sense Mendel's law, some of the daughter cells developed and arranged themselves after the pattern of the original ancestor and the cell group in which this ancestor existed. Such cells behave in a tumor very like the original nonmalignant and normal cells from which the tumor developed. Other daughter cells develop characteristics similar to the undifferentiated embryonal cell from which the involved organ arose. Between these two extremes, all possible biologic, histologic and physiologic differentiations may occur.

The sensitivity of any cell to irradiation is dependent largely upon its biologic activity. Ordinarily, the greater this activity, the larger is the nucleus proportionate to the total cell mass. It is well known that the nucleus contains most of this matter which is vital to the life and reproductive activity of the cell. Thus, purely on the

theory of chance, the possibility that the nucleus will be struck by a moving electron is greater in more active cells, and the possibility of vital damage is proportionately increased. Ordinarily, the same factors which were responsible for the proportionately greater mass are associated with a greater chemical activity and consequently greater atomic instability within the nucleus. This, in turn, renders more likely the disruption of component atoms by the influence of surrounding electromagnetic forces.

Clinically, then, if we are certain that a malignant tumor is contained entirely within a certain area, and that there have been no blood-borne metastases, we can cure this tumor by radiation if we destroy all of the surrounding and immediately underlying and overlying normal tissue. If this destruction is compatible with the life of the host, the patient can be cured of the malignancy. Similarly, if the site of the tumor and its surrounding tissues can be completely excised surgically, and there has been no blood-borne metastasis nor microscopic extension of the malignancy beyond the site of resection, the patient can be cured of cancer. If, however, the tumor has extended, through the lymphatics or by direct extension, into vital structures, the loss of which by destructive effect of radiation or excision would not be compatible with the life of the patient, then that cancer cannot be cured by radiation or by surgery. When curable by neither radiation nor surgery, a combination of these procedures may be used. In the first place, radiation in an amount which can

be easily borne by the surrounding normal tissues is administered. In many instances, all of the malignant tissue which has extended beyond the area which can be readily excised is of a highly undifferentiated and, therefore, radiosensitive type; and this is particularly true where these cancer extensions are microscopic, and where the daughter cells deposited in regional lymph nodes have not had the opportunity to develop throw-backs to the normal highly differentiated and therefore, radioresistant type. If, therefore, extensive courses of radiation are given to all the tissues where the cancer might have extended beyond a point which is resectable, and the surrounding normal tissues have not been seriously handicapped by such radiation, these outlying sensitive cancer cells can be destroyed completely, leaving for the surgeons only resection of the primary tumor and its immediately adjacent metastases to complete the cure. A third possibility must also be considered where blood-borne metastases have taken place before the patient is observed. In these instances, quite naturally, only palliation can be expected from any known form of therapy. Depending upon the type of case, these procedures may be either surgical, radiological or a combination of the two.

In this essay we have endeavored to describe in a practical, simple way the effects of radiation on living tissue. An attempt has also been made to put on a biologic basis the necessity for cooperation between the radiologist, the surgeon and the pathologist in the handling of all cancer cases.



# EARLY DIAGNOSIS OF CANCER

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IN daily practice, the physician is often confronted with the diagnostic problem raised by the patient who comes to him in response to the dictum, "See your doctor early in all cases of doubt when some abnormal growth is noted." While there is no standard method whereby early cancer can be recognized or a proved biologic test by which its beginnings can be identified, to the careful physician certain clinical manifestations do indicate abnormal tissue reactions which suggest the probability of cancer.

The increased effectiveness of surgery and radiation in curing cancer is not compensating for the increased incidence of cancer. There has been no appreciable reduction in the annual cancer death rate. As a matter of fact, it is on the increase. The fundamental problem of cancer control is not million volt x-ray machines, cyclotrons, freezing or boiling. It is still *early diagnosis*. Because of the high curability of early cancer, it is the responsibility of every doctor to become a specialist in the recognition of the early manifestations of cancer.

Cancer may appear in visible, palpable form or manifest itself as an abnormal physiologic phenomenon. Definite proof rests with substantiated pathologic and/or radiologic examination. In a general way, malignant conditions may be suggested by odor, mass, growth, induration, fixation, bleeding and interference with the normal physiologic functioning of vital organs.

*Odor.* A peculiar cadaverous, gangrenous odor associated with persistent ulceration suggests cancer. The best application of this principle is in oral lesions where an ulcerated carcinoma may emit this odor as distinguished from a luetic sore.

*Mass.* The continued presence of a hard mass growing steadily in an unusual locality and fixed to surrounding or underlying tissues suggests neoplastic development.

*Induration and Fixation.* In tissues normally soft and movable, unusual induration and fixation which persist over a long period of time without resolution point to the possibility of cancer.

*Bleeding.* Persistent hemorrhage always suggests abnormal conditions. When it occurs with unusual periodicity or without following an apparently normal physiologic course, a malignant origin is to be suspected.

*Interference.* An abnormality that interferes with the physiologic functioning of normal channels of ingress or egress may suggest malignancy.

While cancer is a destructive disease, its effects in the early stages may be insidious, showing few of the more pronounced reactions usually associated with the advanced case. In its early stages one cannot note anemia, loss of weight, retracted nipples (in breast lesions) or ribbon stools (in rectal cancer). It is before these pathognomonic changes are perceived that we must recognize the symptoms of malignant change.

Examination for cancer must be carried out painstakingly and with patience. The history is important. A persistent interference with normal physiologic functioning that gradually increases the distress of the patient, e.g., difficulty in swallowing, first slight, later more marked, with increasing change in the character of the food that may be swallowed, suggests a lesion in the esophagus. Careful inspection of a new growth or sore not tending to heal



may reveal an early malignant change. In some cases transillumination of a growth may show alteration of normal conditions, arousing suspicion of cancer. Palpation often gives a clue to malignancy, for cancer growths are often infiltrating and stony-hard. Where doubt exists, a biopsy of the growth may prove the condition. In early cases the biopsy itself may effect a cure by the radical removal of the small lesion.

*Skin.* The most common types of skin cancer are the basal cell and the squamous cell epitheliomas. While diagnosis by histologic study is quite easy, clinical differentiation is not always possible, especially in the early stages of the disease. In most instances basal cell lesions are found on the skin of the face or head in older people and are frequently multiple. The ordinary basal cell type of skin cancer may begin as a nodule which slowly grows, ulcerates and produces a small crater with rolled, pearly, indurated edges. Sometimes it is hidden under a persistent scab which when torn off leaves a new peeling scab on a granular base. Often, especially in older people, the cancer is a transformation of previously existing keratosis so often seen in the aged. When the lesion grows and extends rapidly with ulceration and destruction of the superficial and deep tissues, it is probably the rodent ulcer type of basal cell cancer. A keratotic lesion that bleeds readily, that becomes indurated and does not heal under treatment with some bland ointment always presupposes cancer of the skin. Basal cell lesions rarely metastasize.

Squamous cell epitheliomas are more serious lesions. They may appear anywhere on the skin, including that of the appendages. They grow fast and ulcerate rapidly. The gross signs are similar to those described with basal cell cancers; namely, an elevated new growth with rolled, whitish, pearly edges. They differ from basal cell lesions in that they invade the adjacent lymphatics to yield a deep induration and frequently extend to the first line of lymph node drainage. These character-

istics, however, do not aid much in differentiating one from the other, and frequently only histologic study will prove of diagnostic aid. Occasionally in a slow-growing, keratinizing squamous cell carcinoma, the outer, horny layer of epithelium will not be desquamated and will pile up to form a cutaneous horn. A basal cell epithelioma does not form such a horn.

*Oral Lesions.* Leukoplakia itself is not a sign of malignancy, but occasionally a malignant ulceration is engrafted on a persistently irritated, long standing leukoplakia. Less commonly, a leukoplakic patch may become thickened and infiltrate the deeper tissues without ulceration.

Tuberculosis of the lip occasionally is seen but in practically every case it is associated with active pulmonary tuberculosis. Malignant lesions occur most often on the lower lip, appearing as an indurated ulcer at the mucocutaneous junction that persists and does not heal under simple measures. When associated adenopathy is palpable, the diagnosis of malignancy is apparent. The history of a sore beginning with a smoker's burn is suggestive, too, when the ulceration following such trauma fails to heal under simple care. It must be remembered that the presence of syphilis does not lend benignity to a persistent lesion; for this disease and cancer can coexist in the same individual. Likewise a positive Wassermann test does not necessarily signify that a persistent lesion is syphilitic. It may be malignant as an added condition in this patient.

Because of the color, recognition of a melanoma is obvious. To distinguish a benign from a malignant melanoma, fixation, rate of growth and change in character must be evaluated. A benign melanoma may be present for many years and then give evidences of sudden rapid growth, encrustation, bleeding, increased or decreased pigmentation, change in contour, deeper fixation, all signs of a malignant change. A persistent soreness of the tongue, cheek or gums with painful swallowing and foul odor of the mouth often suggest a

malignant condition. The tongue is the most common seat of cancer in the oral cavity. In a large number of cases intra-oral cancer is associated with syphilis and in many instances may occur superimposed upon an old leukoplakia. In nearly all cases, poor dental hygiene, jagged, rotten teeth or ill-fitting dentures tend to be the exciting cause of ulceration and cancer. A persistent ulceration or infectious process that does not heal readily under anti-septic or medical treatment, including the removal of irritation, should be suspected of malignant change and tested by biopsy.

A tonsil harboring a malignant process will appear, in the early stages, as a diffusely enlarged gland. Soon, however, it ulcerates and is covered with a dirty-looking hemorrhagic coat. If discrete and hard neck nodes are present, the diagnosis of cancer is quite evident. If both tonsils are persistently swollen and there is generalized adenopathy throughout the body especially in a young person, lymphosarcoma should be suspected. Biopsy should be employed to sustain the diagnosis of malignancy.

Lesions of the larynx offer a difficult problem in diagnosis. Not all hoarseness is due to cancer nor is every growth on the cords malignant. However, a persistent hoarseness warrants careful investigation of the larynx. A papillary growth which ulcerates, recurs after excision and invades surrounding structures, is malignant. Any persistent ulceration with associated adenopathy makes the diagnosis of cancer of the larynx most reasonable. Carcinoma of the extrinsic larynx may not involve the cords and hence be unattended by hoarseness. Such lesions should be confirmed by biopsy. X-ray examination of the chest and blood serology for syphilis may help identify the lesion.

*Lymphaenopathies.* Generalized lymph node enlargement with or without splenomegaly gives rise to the differential diagnosis between Hodgkin's disease, lymphosarcoma, leukemia, giant follicular lymphadenopathy, polymorphous cell sarcoma

and sometimes syphilis. Only a leukemia can be positively identified by a simple office procedure of blood count. To establish the diagnosis of one of the other conditions, biopsy and blood test must be performed. When available, x-ray therapy is a convenient therapeutic test.

Localized lymph node enlargement direct attention to the limited anatomic situation. Nodes in the neck may be congenital, such as lipoma, cystic hygroma, cysts or angiomas; they may be benign infectious nodes, as parotitis, tuberculosis, or lymphadenitis draining an infectious area. A more positive hardness of a node must raise the suspicion of a metastatic focus, such as, the superficial and deep cervical chain draining the head and neck or bronchus; a Virchow's node from the gastrointestinal tract, axillary node from the breast, etc.

*Breast.* Cancer of the breast occurs mainly in women. Usually the first symptom of which the patient complains is a "lump" felt somewhere in the breast. Associated symptoms may be discharge from the nipple, pain in the breast or arthritic pains described as neuritis, sciatica or lumbago. Obviously not every lump in the breast is malignant but it is a good rule to consider such abnormal findings malignant unless proved otherwise. The importance of early diagnosis in breast cancer must be recognized when one considers that only in cases in which the tumor is strictly confined to the breast is it possible to promise a complete cure. When node metastasis is present even in the operable cases, the chance of permanent cure is reduced appreciably.

Inspection offers an aid in diagnosis. An irregular alteration in the contour of the breast, marked engorgement of the superficial veins, boggy edema of the breast, elevation and retraction of the nipple, orange peel skin—there are all suggestive signs of a malignant process, and in combination may be pathognomonic. Obviously, palpation offers the greatest help in establishing the diagnosis of breast

dyscrasias. A soft, freely moveable encapsulated nodule in one or both breasts is probably benign, but must be so proved by hystologic test. Masses composed of dilated ducts with fibrous strands, usually occupying the outer quadrants with a contributory history of pain at the time of the menstrual periods, are benign. A hard tumor localized or spreading in ameba-like fashion, not tender to touch, must arouse a strong suspicion of cancer. Such a tumor accompanied by information gained by observation, as cited above, is certainly cancer. A hard node in one axilla is positive substantiating evidence. Slight puckering and adherence of the skin to the underlying mass is suggestive of cancer.

Another diagnostic procedure (Scott) which has proved useful even in very early cases of breast cancer is as follows: Since cancer produces thickening of the interlobular fascia of the breast so that pull or pressure causes them to make depressions in the skin, a ray of light striking tangentially across the breast in a darkened room makes these depressions appear as shadows. In some instances this is a much more dependable early sign than retraction of the nipple and appearance of nodes which are normally late indications. The glancing light casts an irregular shadow proportionate to the size and depth of the depressions. With practical experience this test should prove quite accurate as an early diagnostic procedure. A rapidly growing, hard, very large tumor with pain suggests sarcoma.

Occasionally, tuberculosis of the breast is uncovered. The lesions are multiple, painful, fluctuant and ulcerating. Systemic symptoms as fever and night sweats are present. A primary infection can be isolated elsewhere.

Transillumination is of little assistance in diagnosis. It does not offer conclusive evidence regarding the benignancy or the malignancy of the tumor. Roentgenography of the breast is as yet too indefinite to warrant reliance on it for differential

diagnosis. In all cases surgical excision of the tumor with pathologic study must be employed to confirm the diagnosis.

*Lung.* Cancer of the lung yields a wide variety of symptoms so that no specific criteria can be established. Especially is this true in early lesions. The most common symptoms are persistent, dry, irritative cough with pain in the chest. The cough is persistent and fails to respond to the usual medical treatment. Sputum may be scant or profuse, bloody or clear. Hemoptysis is an alarming symptom. The lesion usually appears in people of middle age. In early occlusion of the bronchus, wheezing, asthma-like breathing occurs along with an aching constriction of the chest. Physical signs are not significant in early stages. Advanced involvement may cause pleuritic signs, too. Fever due to secondary infection is present in many cases. Fluoroscopic, roentgenographic and bronchoscopic examination may prove the lesion. At times a metastatic node in the axilla or supraclavicular area may suggest the diagnosis.

*Gynecology.* Early symptoms of ovarian cancer are not often encountered, as this tumor is silent until it reaches a large size. Irregularities in the menstrual cycle, loss of weight, gradual insidious enlargement of the abdomen and occasional pelvic distress may be the symptoms deserving of investigation. Age is no criterion, since young females commonly have ovarian cancer. Advance of the disease is usually accompanied by pelvic pain, ascites, cachexia and pain.

Cancer of the cervix is the most common type of malignancy in the uterus. The most frequent and early symptom is bleeding. Any abnormal vaginal bleeding requires investigation. The early signs of cervix cancer are difficult to visualize. The iodine test, Schiller's test, is based on the normal action of glycogen in the presence of iodine. Cancer tissue is free of glycogen and therefore the tissue so involved does not show the characteristic brown iodine

stain. Unfortunately, this test is not effective in all instances. Foul-smelling, bloody discharge associated with an irregular ulcerated lesion, postmenopausal bleeding and irregular premenstrual bleeding are all suggestive of carcinoma of the cervix. A friable granulating ulcer with induration, readily bleeding on manipulation, is a presumptive cancer. Induration, which is a later sign about an ulcer of the cervix, suggests malignancy. Biopsy, however, is necessary in all cases to establish the diagnosis.

Cancer of the uterine corpus is not easily recognizable in its early stage. Abnormal bleeding is the most common complaint. It may occur before or after menstruation. When functional causes are ruled out, persistent abnormal bleeding suggests malignancy and must be ruled out by curettage biopsy. Pain, uterine enlargement, foul discharge and associated pelvic phenomena are all late symptoms.

*Prostate.* The prostate is the second most frequent organ involved with cancer in the male. The disease in this area is slow-growing and often gives very few symptoms. The tumor may be rather small and confined and yet widespread, distant metastases may occur. About one-third of all cases metastasize to the skeleton. The diagnosis in the early stages is not readily made because the symptoms are not marked. The earliest symptoms are those usually associated with urinary discomfort. A rectal examination may reveal an enlarged prostate. Usually the organ is hard and encapsulated. When it has broken through and infiltrated the surrounding tissues, it is already in the advanced stage. Frequency and urgency of urination may be the only symptoms. Occasionally slight bleeding on urination may indicate extension into the bladder or simple ulceration. In a man of the cancer age, a hard, irregular prostate with urinary discomfort and complaints of rheumatism in the pelvis suggest cancer of the prostate.

*Bladder.* Lesions of the bladder may be

benign or malignant. Papillomas, which give symptoms somewhat similar to cancer, are commonly the precursor of cancer. The earliest symptom is hematuria. Occasionally urinary blockage may occur especially if the tumor is in the bladder neck. Metastases occur late in malignant bladder conditions. This helps to differentiate the hematuria due to renal involvement in which metastases are early and common.

*Kidney.* Cancer of the kidney is the most common tumor of the kidney. Cancer of the kidney metastasizes early and is widespread. The symptoms, aside from hematuria in the early stages, are not significant. Occasional pain and hematuria occur. At times the symptoms are noted only because of the metastatic involvement, such as lung or bone. In children, the kidney neoplasm most commonly seen is Wilm's embryonal adenocarcinoma. In this case the symptoms begin early in life with a constant pronounced swelling of the abdomen. A tumor mass is usually felt and there may be urinary disturbances. The x-ray examination in kidney tumors may at times identify an early lesion.

*Testicular Tumor.* These tumors are unilateral, hard masses which grow slowly with very few symptoms. Pain in the scrotum may be the first sign of an involvement. Aspiration biopsy may permit identification of the tumor. Even in early suspicious cases the Aschheim-Zondek test may be significant and helps confirm the diagnosis. Metastases are early and widespread.

*Gastrointestinal Tract.* The most common site for cancer in the human is in the gastrointestinal tract. However, the symptoms associated with cancer in this part of the body are rarely noticeable in the early stages of the disease.

Age is no longer considered an inexplicable defense against the occurrence of cancer of the stomach for we now find cancer present very often in the younger adult. The earliest symptoms are those of indigestion. A long standing, con-

stant indigestion with loss of appetite, some weakness and possibly eructations of blood-streaked mucous should suggest the possibility of an organic lesion. X-ray examination may at times reveal an early cancerous growth. The gastroscope may permit the visualization of a lesion in the stomach. Gastric analysis showing absence of HCL and the presence of some blood is suggestive. Certainly, the most important dictum to be remembered is that the sudden appearance of dyspeptic symptoms in an individual of the cancer age must be considered due to cancer until proved otherwise. Unless a mass is palpable on abdominal examination, reliance must be placed on symptomatology for a presumptive diagnosis of cancer of the colon. A lesion on the right side should suggest itself by an unexplained anemia and loss of weight. A left-sided lesion may produce

melena, constipation or diarrhea. In any case, the suggestive lesion must be corroborated by competent x-ray examination.

Cancer of the rectum is a common lesion often recognized only too late for cure. Any symptom referable to the gastrointestinal tract below the stomach deserves a finger examination of the rectum. In that way many early cancers will be identified. Obviously, bleeding from the rectum calls for a digital and proctoscopic examination. The classic symptoms of alternating diarrhea and constipation, ribbon stools and pain represent an advanced stage of the disease.

While cancer in its early stages is usually symptomless, by careful attention to details in history and physical examination, the attentive physician may often detect an early neoplastic development which is readily curable.



# BOOK REVIEWS

**MINOR SURGERY.** By Frederick Christopher, M.D. With a Foreword by Allen B. Kanavel, M.D. Fourth Edition, Reset. With 639 Illustrations. Philadelphia, 1940. W. B. Saunders Company.

This standard textbook first appeared in 1929 and other editions appeared in 1932 and 1936. For a decade it has been one of our favorites, and to us this fourth edition is both timely and welcome.

There has been no end of discussion concerning the line of demarcation between major and minor surgery. There are those who claim there is no such thing as minor surgery. We feel the author has put the problem tersely and clearly in the first paragraph of his Preface to the First Edition. He wrote, "*Minor Surgery* is the surgery which has a low mortality; which requires but few assistants; which generally is done in the hospital outpatient department or in the office. It includes the large majority of surgical cases; the every-day surgical conditions. All minor surgery potentially is major surgery; often a distinction cannot be made."

We learn from the Editor of *The American Journal of Surgery* that in the future instead of a *Minor Surgery* Number he will call it "Every-day Surgical Conditions." But this is an aside.

Certain books are written, appear, reappear in new editions, and one day not only have they become standard but a very part of our medical structure. When we wish to refer to a chapter dealing with a minor surgical problem, we naturally and unconsciously turn to Christopher's book. It is not that we know the author or that we are one of his friends (we would not know him if we sat together at a lunch table); it is not because we have not read similar books on the subject; but it is because we believe it is the best and most complete work on the subject we have today. And so to us this fourth Edition is both merited and welcome.

**A METHOD OF ANATOMY. DESCRIPTIVE AND DEDUCTIVE.** By J. C. Boileau Grant. Second Edition. Baltimore, 1940. The Williams and Wilkins Company. Price \$6.00.

This book was first published in 1937 and was reprinted in 1938. Now a second edition is offered the profession. When a reader goes through this work, the reason for its popularity will be apparent.

In this second edition an introductory section on the systems of the body has been added and certain hiatuses have been filled. Various sentences and paragraphs have been reworded, a hundred new illustrations and diagrams have been added and the index has been enlarged. It is a solid, well written book.

Medical students and surgeons will find "*A Method of Anatomy*" invaluable as a textbook and a reference work, which is sure to enjoy a long life of usefulness.

**A TEXTBOOK OF HISTOLOGY.** By Harvey Ernest Jordan, PH.D. Eighth Edition. New York, 1940. D. Appleton-Century Company. Price \$7.00.

Dr. Jordan's *Histology* is an old standby and friend. For nearly twenty-five years it has been familiar and of great value to thousands of medical students. One sees it today on the shelf in laboratories throughout the land, and we sincerely wish that we had had a book as well and as interestingly written when we were a student. There is no need to tell what the book is about. It is a textbook on histology and covers the subject thoroughly. The profuse illustrations are of a high order of excellence and from the publisher's angle it is typographically satisfying. The book is readable and of a size that makes handling easy; the type is large and clear and the paper stock very good.

So this *Textbook of Histology* by Harvey Ernest Jordan is a most excellent work from every viewpoint. A book must be good to go into eight editions over a span of twenty-four years, and medical students and practitioners of medicine are fortunate they have such a book for study and reference.

**DIAGNOSIS AND TREATMENT OF HEAD INJURIES.** By Sidney W. Gross, M.D. and William Ehrlich, M.D. Introduction by Percival Bailey, M.D. New York, 1940.

Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers. Price \$5.00.

This is a timely and worth while book. It is *timely* because an authoritative book on this topic is welcome in this age of head injuries due mainly to the automobile. Four or five decades ago the incidence of head injuries was insignificant as compared with their everyday, commonplace occurrence at the present time. It is *worthwhile* because the authors know their subject, have had no end of clinical experience with this type of case and present their thesis with clearness and restraint.

The contents embrace applied anatomy of the head, intracranial physiology, the mechanics and pathology of head injuries, method of examination, classification of head injuries, principles guiding the treatment of head injuries, injuries of scalp and skull, extradural hemorrhage, traumatic subdural hematoma, fractures of the skull with involvement of the paranasal sinuses, mastoids and middle ear, suppurative cranial and intracranial disease resulting from trauma, gunshot and other penetrating wounds of the head, cranial nerve injuries, convulsive seizures following head injuries, surgical technique, complications and sequelae of head injuries, head injury and disease of the nervous system.

There is a bibliography, an index and many valuable illustrations. It is an excellent book.

**BACILLARY AND RICKETTSIAL INFECTIONS ACUTE AND CHRONIC.** By William H. Holmes, M.D. New York, 1940. The Macmillan Company. Price \$6.00.

This is a textbook of 676 pages by one who has had thirty years of medical practice and twenty-seven years of teaching.

The author tells us in his Preface, "In the preparation of this book it was desired to cover each subject with a reasonable degree of completeness consistent with its social, medical and historic importance, without producing an exceedingly bulky and expensive volume. This was accomplished by omitting illustrations and by the decision not to attempt consideration of all the infectious diseases in a single volume. The present volume, therefore, deals only with the bacillary and rickettsial infections, leaving the virus diseases, and the infections of coccal,

spirochetal, and protozoal etiology for subsequent presentation."

This book covers: the pasteurella infections, the rickettsial infections of man, the brucella infections, the enteric infections, bacillary intoxications, hemophilus infections, the mycobacterial diseases, and miscellaneous bacillary infections (anthrax, glanders, melioidosis, etc.). There is a bibliography at the end of the chapters and the index is ample.

The reader will be pleasantly surprised when he reads this work to note that he has come in contact with a new kind of textbook, an experience both refreshing and stimulating. It goes without saying that the author is an authority on the subject and the text matter comprises the last, up-to-date thoughts on this subject.

**ABDOMINAL OPERATIONS.** By Rodney Maingot, F.R.C.S. (ENG.). Two Volumes. New York, 1940. D. Appleton-Century Company.

The author tells us in the first sentence of his Preface that "This book is intended to present a detailed consideration of the technique of modern abdominal operations." In addition it deals with the choice of operations in the individual case, "the difficulties and dangers which sometimes arise during the conduct of operation, the pre- and post-operative treatment, the immediate and remote results of the various measures described, the clinical, pathological and other aspects of most of the destructive lesions of the abdominal viscera, and many problems in abdominal surgery." This is the blueprint. From it the author has done two worth while, up-to-date volumes.

Volume I deals with abdominal incisions, stomach and duodenum, spleen, pancreas, gallbladder and bile ducts. Volume II deals with liver, veriform appendix, peritoneum, mesentery, omentum, external abdominal hernia, intestines, and postoperative complications. There is an index to the whole. The illustrations are profuse, well done and some are in color.

Interns and surgical residents are sure to find this work of the greatest value and help to them. We hint that it would be an excellent investment on their part to own these two volumes. Surgeons will enjoy browsing through its pages and are sure to gather many useful items along the way. We rate it most highly.

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